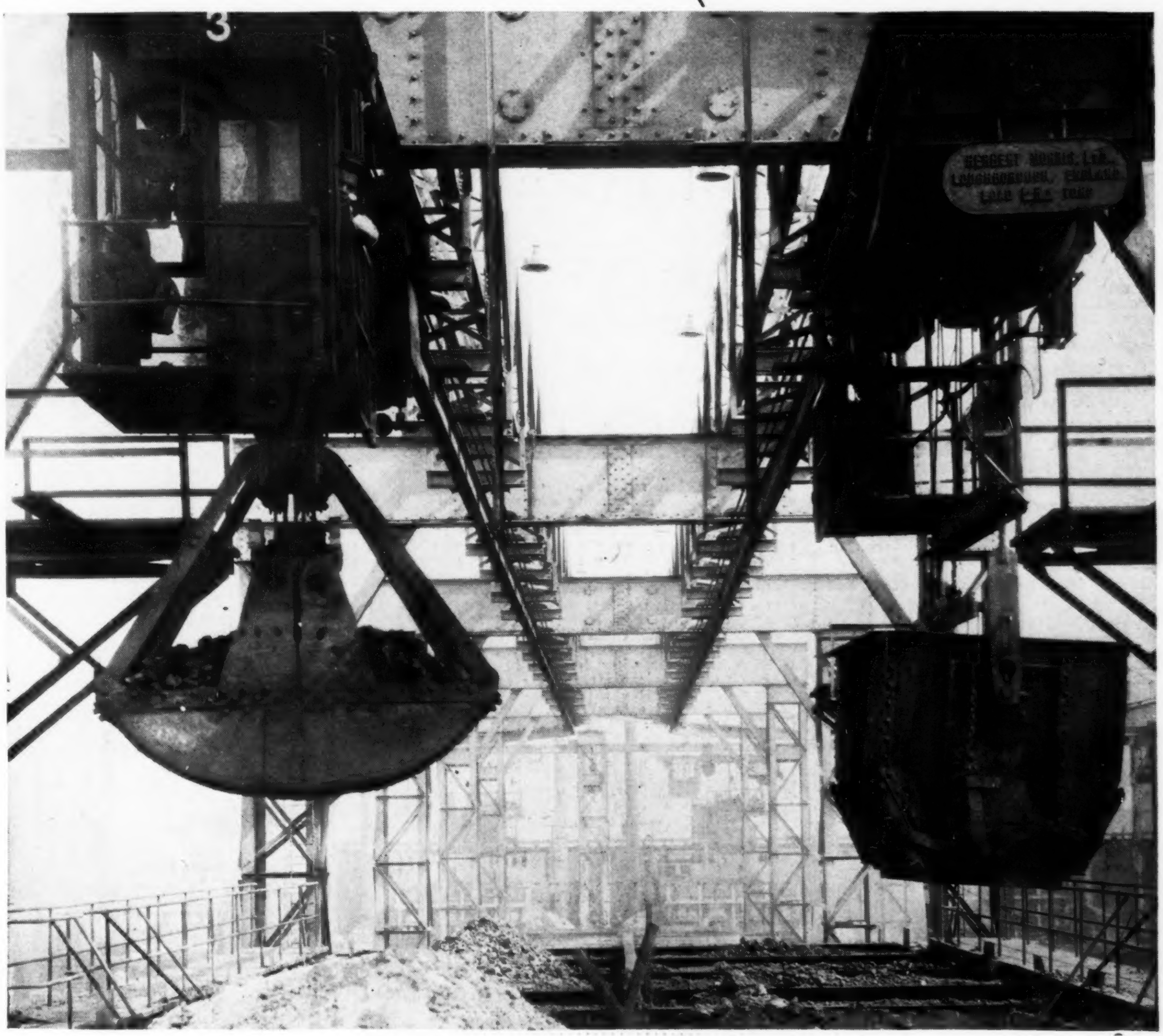
Engineering and Mining Journal

WITH WHICH IS CONSOLIDATED ENGINEERING & MINING WORLD

NEW YORK LONDON



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July, 1932

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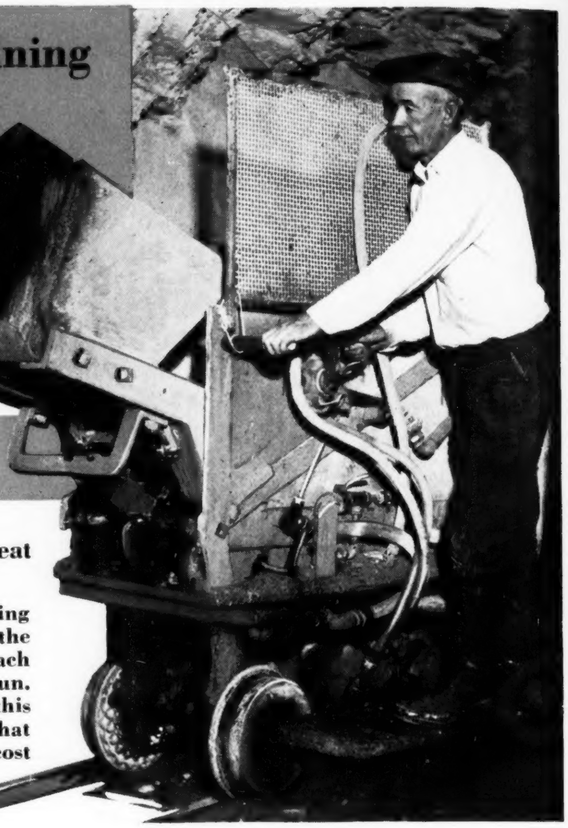

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A. W. ALLEN, *Editor*

Too Liberal Mining Law Retards Mineral Discovery

THE extent of stocks of the major metals should not blind any country to its future needs of minerals, especially if it hopes to continue to supply itself largely from domestic resources. Known ore reserves in the United States have been greatly depleted, though they be more than sufficient for many years at the present rate of consumption. To advocate an intensive search for new deposits at this inauspicious moment might seem unwarranted, save with respect to gold. But if an easily removable obstacle were found impeding the prospecting and development of mineral lands, the removal of this difficulty might properly be suggested. Strangely enough, such an obstacle results from one of the provisions of the United States mining law.

This mining law has been famous for its liberality. Liberal also have been its interpretation by the courts and its administration by the Federal Government. One of its generous provisions permits the locator of a lode claim to hold it indefinitely without proceeding to patent it, provided he annually perform the so-called assessment work upon it to the value of $100, a provision that has just been suspended for twelve months with respect to the work required to be done during the fiscal year ended July 1, 1932. As a result of such liberality the vast bulk of the mineral lands of the public domain has long since been staked and is held by a myriad of companies and individuals.

Included in these holdings, patented and unpatented, are the mineral properties that are or have been producing ore, or on which earnest bona fide efforts have been expended to bring them to production. Also included are the claims staked, perhaps years ago, on the strength of evidence of mineralization and since held with only a pretense at performance of annual assessment work or else with the minimum effort necessary to retain possession of them. The holder of such a claim lives in the hope that some day the property may prove valuable, perhaps because of work done and paid for by others on adjacent ground. Remaining thus in possession, though inactive and without intention of becoming active if it will cost him money, he prevents others with money and honest purpose from taking up the ground and attempting to prove its value. Such a situation the law was never intended to create. Development of the country's mineral resources is thereby retarded.

Entirely fair to claim holders and in the public interest would be a limitation of the period in which possession of a claim could be retained solely by virtue of nominal assessment work. As to the disposition of the claim when this period had expired, various suggestions might be made. The purpose of the mining law would be served, however, if someone else were permitted to try to make a mine of the prospect.

Curiously, the General Land Office at Washington declares itself unable to state what part of the public domain is covered by unpatented mining locations. The facts, apparently, are buried in the many County Recorder's offices scattered throughout the land. Statistics that might be compiled from such data would prove illuminating and suggestive of reform.

Developing New Markets With Processed Minerals

IN THESE DAYS of decreasing demand, lowering prices, and increasing competition, the producer will do well to give heed to any opportunity for developing new market outlets, or new products; perhaps for both. For many years the producer of non-metallic minerals overlooked a tool lying ready at hand, designed and tested and proved by the ore dresser and the metallurgist. That tool, processing, as contrasted with and supplementing ore dressing, is now being applied to increase the sale value of mineral products. The physical properties of a mineral may thereby be so changed that new markets can be found for it—markets that may replace those lost by competition. By the application of this adopted technique a large-tonnage and low-grade enterprise operating at a loss may be transformed into a small-tonnage operation yielding a high-priced product and operated at a profit.

An innovation of this character was described in a recent issue. The property in question—a crystalline limestone mine—formerly produced marble for building purposes, but competition caused suspension of operations. Subsequently, under other and more enterprising auspices, the property was reopened, a grinding plant erected, and several high-grade, sized products were made and sold to the paint and linoleum industries, as well as a conditioning agent for users of concrete. On a weight basis, the processed product is many times more valuable than the marble from which it is made. Less material is needed to yield a satisfactory return. The life of the property has been extended. A larger capitalization is justified. Refinements in mining and other technical phases of operation have been introduced.

Equally satisfactory and profitable results can be secured at other mineral properties by the use of modern grinding and classifying equipment, and the development of a processing technique suited to the requirements of a broad industrial demand for finely divided products.

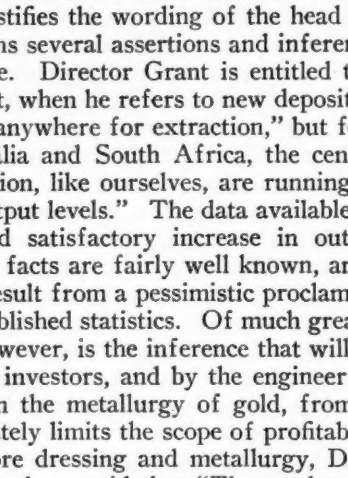
Even a low-grade hematite deposit of no value as a source of iron ore has been made to yield a salable paint pigment.

New products and products of improved quality are finding acceptance today while standard grades remain unsold. Recognition of the potentialities of this new trend will stimulate improvement in general business conditions. Mining, no less than the finished product and manufacturing industries, can assist materially in bringing about such improvement.

Expected Gold Output Has Materialized

HEADLINES in a metropolitan newspaper of wide and powerful influence proclaim that "Expected Gold Output Has Not Developed," that "Miners Stimulated by Low Costs, But Head of Mint Doubts Much Ore Is Left." The impression created by publicity of this character is likely to be unfortunate. Prospecting and exploitation will be discouraged, to the detriment of a branch of mining activity that has maintained its full contribution to national buying power when almost all other industries have been obliged to curtail, to add their quota to the swelling ranks of the unemployed.

The account was inspired by an interview with the Director of the United States Mint at Washington. Its substance justifies the wording of the head and subhead, but it contains several assertions and inferences that lack verisimilitude. Director Grant is entitled to an expression of doubt, when he refers to new deposits of ore, that "the gold is anywhere for extraction," but few will agree that "Australia and South Africa, the centers of older gold production, like ourselves, are running along at accustomed output levels." The data available indicate that a steady and satisfactory increase in output is being realized; the facts are fairly well known, and little harm is likely to result from a pessimistic proclamation at variance with published statistics. Of much greater retarding influence, however, is the inference that will be drawn by bankers and investors, and by the engineer who has not specialized in the metallurgy of gold, from a statement that inaccurately limits the scope of profitable operations. Discussing ore dressing and metallurgy, Director Grant is reported to have said that "The art has developed to the point that if a given rock deposit contains as much as $1 per ton in gold—some operations are being successfully conducted on rock masses which run lower than that—it can be profitably extracted. This is a surprising thing, when you consider what it means to recover a twentieth of an ounce of gold from a ton of rock, which rock has to be dynamited out of place, transported to the surface and ground finer than flour to let the chemicals and the agitation do their work."



Much harm is being done by thoughtless repetition of the fiction that every ton of ore must of necessity be ground "finer than flour" and treated by chemicals and agitation if the gold therein is to be recovered. Such a narrow conception ignores the fact that most of the world's gold supply is obtained by methods that do not involve fine grinding of all the ore from the mines, or even a part of it, or its treatment by chemicals or by agitation. In some instances all the ore is finely ground and cyanided by agitation, but opportunity for more economical treatment is seen in majority practice, involving mill concentration by sorting and discard, or large-scale concentration of placer gravel, or coarse crushing and cyaniding, or amalgamation.

When the legend is finally laid to rest that all gold ore, to be beneficiated at a profit, must be ground finer than flour and treated by agitation and chemicals, an influence unfavorable to the exploitation of many low-grade ore deposits known to exist and yet to be discovered will be removed.

Developing an International Testing-Screen Series

LATE in 1930 a step forward was made in the direction of agreement on the subject of a uniform testing-screen series. At that time the representatives of the Institution of Mining & Metallurgy on the Screens and Standards Committee of the British Engineering Standards Association favored the Tyler series, but a compromise was necessary because the dimensions of the British Standard wire gage differed from those used in the manufacture of screens covered by the American series. The major disadvantages of the I.M.M. series were obviated, and the major advantages of the Tyler series were incorporated in a modified British series. Although the apertures of screens in the Tyler series and the British series were almost identical, the mesh designations differed, because of the lack of uniformity in wire dimensions in vogue in England and America, respectively.

Further progress toward simplification may be expected as a result of the appointment by the American Standards Association of a committee—the activities of which are to be directed by the United States Bureau of Standards and the American Society of Testing Materials—to investigate prevailing specifications for sieves or screens for testing purposes, including nominal dimensions, tolerances, designation, and methods of verification and statement of result. This committee will cooperate with the International Standards Association, which has been active in Europe for many years.

Engineering efficiency connotes uniformity and simplicity. Research on metal-production methods, and on the processing and preparation of non-metallic minerals for the market, utilizes the testing screen for important investigations and conclusions. The interchange of information on technical matters will be greatly facilitated by agreement on what constitutes the best practice in screen design and in the interpretation of sieving results.

Trends With Silver And Iodine

WHEN opportunity apparently offered for additional outlets, effort made to stimulate interest in an increase in the consumption of silver by industry was interpreted as a reflection on the efforts and perspicacity of the marketing organizations. Repeated recommendation during the prosperity period that the vast potential demand for sterling-silver tableware be exploited by a reduction in retail prices met with apathy or skepticism. Proponents of the policy of increasing sales thus were told that silver would no longer be considered as a precious metal if the spread between first cost and selling cost in manufactured form was not maintained. The result, of course, was that only the wealthy could afford to pay the prices asked; wage and salary earners continued to harbor resentment at what was interpreted as an attempted extortion on the part of silversmiths.

Depression has brought humility. Now that the potential market for silverware has almost disappeared, prices have been reduced to a reasonable level. In regard to silver goods, as with most luxury and art purchases, the cynic has said that never before could so much be bought with the dollar the customer hasn't got; but, nevertheless, evidence is available to show that new uses for silver will attract new customers. The L. C. Smith company recently introduced a new Sterling Model portable typewriter, priced at $125, although sales emphasis was placed on the ordinary $65 model. Those who had sponsored this commercial adventure experienced a surprise: The first five hundred machines with the silver casing sold in two weeks, and orders are still being received in satisfactory numbers.

The claim that all has been done that could be done to increase the consumption of silver, that no further opportunity for research existed, was not well founded. Recently a patent was granted at Washington for the use of silver as a precipitant for the iodine contained in small amounts of some subterranean waters, particularly in the brines from oil wells. Although the use of silver thus is the basis of a successful commercial technique; in spite of the well-known fact that silver iodide is one of the more insoluble of the halogen compounds —an advantage favoring use of the white metal for this purpose; notwithstanding that, although research on the recovery of iodine from iodized waters has been carried on in several countries for about eighty years, leading to the issuance of about three hundred patents, not one of the processes devised, prior to the one recently protected, disclosed the use of silver for the purpose. This, of course, has been mainly due to the impression created that it has few commercial uses— that its prestige as a precious metal would be lowered by increased trade applications.

Sales of iodine, by the way, have been restricted by a similar attitude on the part of the controllers of the Iodine Trust. A few years ago this publication advised the Chilean producers that, if iodine and the iodides could be purchased at a reasonable price, new uses would probably develop in several industro-chemical fields; and it warned them that no industry ever achieved continued financial success by sanctioning and encouraging deliberate waste of valuable natural resources. Advice and warning went unheeded. Chile today faces a new competition (from iodine obtained from oil-well brine) that is forcing prices to bedrock and discouraging profitable operation.

Unfortunately, the opportunity for intensive research on new uses for metals, non-metallic minerals, and their compounds and byproducts has been curtailed by the force of economic circumstances. Much of the effort needed, involving capital investment the outcome of which in terms of financial return cannot be predicted with certainty, must be postponed until better times, when one hopes that prices will not be raised to a point inhibiting interest in the steady broadening of fields of application of primary raw material and secondary products.

Recovering a Soluble From Gangue Material

THE ECONOMIC RESULTS of a costly experiment in one of the non-metallic mineral industries suggest discussion of the comparative value of bulk leaching and the more complicated process involving separate treatment of the fines. If the subject of the mechanics of leaching had been considered from all angles, with adequate regard to fundamentals and basic principles, justification might be seen for the suppression of further comment. But, although in some instances no criticism can be made of the decision to abandon bulk leaching, one is tempted to point a moral from experience, and to be bold enough to analyze some of the explanations that have accompanied the contention that the simplest form of wet-extraction process is "out of date."

If the fines appear to hinder percolation, they should be removed and treated separately, some aver. But is adequate attention always paid to the truism that the crystalline part of the charge is an essential aid in the prompt and effective treatment of the colloidal part of the charge? Many natural ores contain sufficient crystalline material to permit the efficient leaching of the entire mass by gravity percolation; assuming, of course, that the material to be dissolved is available and that fine grinding is unnecessary from the solubility standpoint. If fine grinding be imperative, gravity leaching is seldom practicable. If coarse grinding be adequate from the extraction standpoint, however, some discussion is advisable before the conclusion is accepted that a segregation of the fines and their separate treatment indicates a new principle that must be accepted as generally applicable and fundamentally logical.

"Flagship" of the expedition of the Sekong River — a 45x6-ft. dugout, equipped with 14-hp. Johnson motor

Mining in French Indo-China

Robert W. Karpinski

WORLD-WIDE INTEREST in Indo-China was revived recently by the exhibits assembled at the International Colonial Exhibition in Paris. The exquisite reproduction of Angkor Vat, a gorgeous and colossal relic of Khmer art, from Cambodia, was the jewel of the show.

Few realize the contribution of French Indo-China to the coal and metal markets of the world. Of particular importance is its anthracite supply, with ideal location adjacent to sea and good harbors. Zinc and tin are the next important mineral products, followed by phosphate, chromium, gold, tungsten, and precious stones. Indo-China, with an area of 285,000 square miles, lies to the east of Siam and to the south of Yunnan province of China and is on the trade route from Singapore to Hongkong. The country is nearly bisected by the Annamite Mountain chain, the peaks of which tower to over ten thousand feet. This dorsal ridge forms the continuation of the Tibetan plateau, which passes to Indo-China through western Yunnan. The enormous Mekong River, forming the frontier with Siam for nearly a thousand kilometers, is one of the most important rivers in the world.

The Annamese, a people of Chinese descent, living principally on the delta lands of the Mekong and of the Red River, make up nearly eighteen million of Indo-China's twenty million inhabitants; among the remainder are about one million Cambodians and another million Laotians, with several hundred thousand aborigines, including Mois, Khas, Meos, and Mans. The 20,000 whites are mainly French, with some Europeans from other countries and a few Americans, principally associated with the Standard Oil Company.

Production of coal increased steadily from 1,103,200 metric tons in 1923 to 1,983,000 tons in 1929, dropping to 1,955,000 in 1930. Only about 70,000 tons represent products other than anthracite. Of the total production, 1,345,000 tons was exported in 1929, and 1,288,000 in 1930. The output per man from the mines, most of which are open-pit operations, has varied from 203 kilos per worker in 1924 to 213 in 1929.

Wages for skilled workers vary from 22 to 50c. per day, and for unskilled workers 16 to 30c. Female workers receive 12 to 28c. per day. Unless otherwise specified, the sums given are in United States dollars. The Indo-Chinese piaster has been stabilized since 1930 at 10 francs, or at a value of about 40c., U. S. currency.

The three major companies operating in the region are the Société Française des Charbonnages du Tonkin, which produces about 65 per cent of the total; Société des Charbons du Dongtrieu, about 10 per cent; and the Société des Anthracite du Tonkin, about 12 per cent of the total production.

Indo-China occupies an important place in the coal industry of the Far East. Taking into account the reserves, and the use of the open-pit method of exploitation, these fields will probably assume greater importance with the increased industrialization of the Orient.

The production of metallic zinc rose from 13,164 tons in 1923 to 25,245 in 1925, and dropped to 15,900 in 1930. The Compagnie Minière et Metallurgique de l'Indochine has the largest mine, Cho-Dien, which generally produces about 75 per cent of the total. In 1930 it employed 2,000 native workers and 25 Europeans. Shipping costs to Haiphong port are about $4 per ton from the mine. Société des Mines de Trang Da produces about 25 per cent of the output, with 750 natives and 11 Europeans. Almost the entire production of these two mines is treated in France or Belgium.

Much of the hope of future importance for Indo-China's mineral production is based on the properties at present operating and being developed in Laos, near the Mekong River, on the frontier line with Siam. Société d'Etudes et d'Exploitation Minière d'Indochine is the most important producer, having turned out 600 tons of metallic tin in 1930, or about 60 per cent of the total Indo-Chinese production. This company operates a series of eluvial properties in Laos, and is said to possess large reserves. In 1929 the ore-dressing plant handled the mine output with 2 rod mills, 16 Wilfley tables, 46 Fossati tables and 10 James tables, 19 Isbell vanners, and 6 Callow screens. The mine run was said to be about 1.5 to 3 per cent tin. The company employed 1,100 native workers and 9 Europeans in 1930.

Two new companies entered the Laos district about four years ago—the Société des Etains du Cammon, and the Société des Etudes de l'Indochine. Both are developing properties similar to those of the S.E.E.M.I., just mentioned. Recently these two merged into a group called Société Fermiere des Etains d'Extreme Orient, employing 1,100 native workers and 23 Europeans. Up to the end of 1930 they had not produced tin ore on a commercial scale.

Prior to 1928, Tonking led in the production of tin in Indo-China, but in 1930 it accounted for only 40 per cent of the output. With the greater development of the Laos tin industry,

Map of French Indo-China

Rapids on the Se San River, Annam, Kontum region

the importance of Tonking is likely to decline.

Société des Etains et Wolfram du Tonkin produced 331 tons of metallic tin in 1930 from alluvial deposits. It employed 2,100 native workers and 15 Europeans. Two other companies operate in this region, the Société des Etains du Haut Tonkin, and the Société des Etains de Pia Ouac. Their production is relatively unimportant.

Formerly, everything had to be shipped up or down the Mekong River to Saigon. Now a good automobile road is open almost all the year from the China coast to the Laos tin district. Contracts were let and work was recently begun on a railway from the China Sea to the Mekong River (Quang Tri to Thakhek). Improvements in means of communication will be of great importance in the development of the Laos tin district. In association with the alluvial tin deposits of Tonking, a small amount of tungsten is mined. This amounted to 140 tons of the metal in 1930.

The zinc mines of Tonking have a small production of lead as a byproduct of their operations—about 59 tons in 1929. Société de la Mine Armorique is developing lead properties in northern Tonking.

Société Chrome et Nickel de l'Indochine commenced production, of 740 tons of Cr_2O_3, in 1930. The company was organized to treat a deposit of chromium containing small amounts of nickel, in the Than Hoa district of northern Annam, partly in a vein and partly alluvial in character. The ore-dressing plant is capable of handling 1,000 tons of concentrate per month.

Société des Mines d'Or de Bao Lac installed in 1928 a dredge of European make capable of handling 1,500 cubic meters per 24 hr. The deposit, supposed to run about 0.65 grams per cubic meter, or about 30c. per cubic yard, occurs along about 15 miles of the Song-Nang River, in northern Tonking. In addition to dredging the main channel of the river, the side valleys were being worked by monitors and sluices. Dredging operations were complicated by rough bedrock and improper choice of dredge equipment, which has considerably delayed the profitable exploitation of what appears to be a large deposit. I understand that after having unsuccessfully tried to strengthen the company's present dredge, its management is considering acquiring one of another type. This property, as well as most of the other mining enterprises at present active, shows evidence of having been worked by the Chinese many years ago. The Laos tin district, the Cho-Dien zinc deposits, and others in the region, are examples of renewed life of old Chinese workings. Cia. Minera de Dos Estrellas, operating in Mexico, organized a company, Société Indochinoise d'Exploitation Minière et Agricole, in February, 1929, to operate the Bong-Mieu gold property, in Annam. The Bong-Mieu property had a small production for about ten years before it closed in 1919, but the Dos Estrellas subsidiary has not had favorable results, according to latest reports. Several companies were organized to prospect gold areas around Tchepone and Kontum, in central Annam, but results were below expectations. This was partly due to lack of men trained in placer work, and also to the slipshod methods that so frequently accompany operations carried on in a mining area during a rush period.

The French have been fortunate, in their colonies of North Africa as well as in China, in possessing phosphate deposits of considerable extent. Société Nouvelle des Phosphates du Tonkin produced 28,490 tons of crude phosphate rock with 300 natives and 10 Europeans. The mines are in Tonking and in northern Annam. Société Minière du Camboge is developing a deposit at Phnon-Sampon. Ore is to be shipped 8 miles over a 60-centimeter railway to Battambang, where water transportation is available. Sapphires and a few other stones are exploited by a Burman colony at Pailin, Cambodia. The production dropped from 5,240 carats in 1925 to 2,230 carats in 1929, and to 630 carats in 1930.

Anthracite is the most important mineral product of Indo-China, and future industrial growth of the Orient may witness greater use of the deposits, which are strategically located. Tin bids fair to play a more important rôle because of developments taking place rapidly in Laos. Zinc production will no doubt be maintained and even increased, should the price situation be favorable. Several gold properties may produce, but considerable work lies ahead in the correct appraisal of tonnage available, the proper selection of equipment, and the economic exploitation of the deposits. In closing I wish to thank the Union Financière Privée, of Paris, for permission to publish the information contained in this article.

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Panning a small stream in eastern Laos

Cost of Producing Gold

S. D. Strauss

ONE of the aspects of the current industrial depression that has most interested economists and scholars is the problem of money. At present, many countries are issuing currency that has no official monetary backing—that is, for which there is no metallic reserve. Two countries, Mexico and China, are using silver as a backing. The countries left on the gold standard are comparatively few: the United States, France, Italy, Spain, Belgium, Switzerland, the Netherlands, the Union of South Africa, and a few less important nations. Yet gold is everywhere recognized as real money and nearly all international transactions are still payable in gold.

A result of this peculiar monetary situation is that everyone is asking whether there is sufficient gold available for our needs or whether it will not be necessary to abandon the gold standard and adopt some form of managed currency. What particularly interests people is the amount of gold that will be available in the future. To keep the gold standard in effective operation, large additions must be made regularly to the gold supply.

Gold production is of course the chief source of new gold. The chief sources of gold production, in turn, are three or four large gold-producing countries. One field alone recovers more than half the new gold production each year. This is the Witwatersrand district, in South Africa, which has 33 large mines, of which 29 recovered more than 100,000 oz. apiece in 1931. Only 14 other mines in the world produce that much. The Witwatersrand mines are all within an area 60 miles long, and many of them have been producing for 40 years. When these mines are exhausted, gold production will apparently show a very great decrease. The prediction has been made that Witwatersrand output will drop 50 per cent in ten years. Much gold-bearing material is available, but it cannot be treated because the cost of production is too high. The cost of production is, in fact, the determining factor in the volume of gold produced. Because of the depression, gold mining has been stimulated. The price of everything the gold mines must buy—such as labor, supplies, fuel—has dropped, and consequently ore that could not be treated at a profit formerly is now available for exploitation.

Gold production in 1931 was more than 21,300,000 oz., compared with 20,150,000 oz. in 1930, and about

United States Mines

	Production		Expenses			Dividends	
	Oz. of Gold	Tons of Ore	Total	Per Ton	Per Oz.	Total	Per Share
Homestake Mining	432,381	1,403,939	$4,381,856	$3.12	$10.01	$2,122,302	$8.45
Alaska Juneau	178,532	4,162,350	2,394,948	0.56	13.41	584,950	0.40
Eureka Standard	48,207	36,622	510,512	13.90	10.59	179,951	0.12
Cresson Consolidated	38,385	80,479	540,527	6.72	14.10	48,800	0.01
Shenandoah Dives	30,561	170,795	389,317(a)	3.30(b)	12.70(a)	....	......
Idaho Maryland	27,797	45,005	324,493	7.20	11.65	....	......
Totals	755,853	5,899,190	$8,541,653	$1.45	$11.30	$2,936,003	......

Mines Controlled by United States Capital

	Oz. of Gold	Tons of Ore	Total	Per Ton	Per Oz.	Total	Per Share
Oriental Consolidated	50,204	208,366	$716,751	$4.16	$14.32	$429,390	$1.00
Benguet Consolidated	80,608	112,524	948,864	8.42	11.75	850,000	0.425
Balatoc Mining	68,065	57,675	580,285	9.90	8.54	675,000	0.675
Totals	198,877	378,565	$2,245,898	$5.93	$11.29	$1,954,390	......

Canadian Mines (*e*)

	Oz. of Gold	Tons of Ore	Total	Per Ton	Per Oz.	Total	Per Share
Lake Shore	441,461	698,624	$3,605,369	$5.16	$8.15	$4,800,000	$2.40
Hollinger Consolidated	487,123	1,640,705	7,275,000	4.43	14.90	3,444,000	0.65
Teck-Hughes	288,950	396,200	2,113,549	5.34	7.31	3,118,144	0.65
McIntyre Porcupine	223,325	558,115	2,547,275	4.56	11.40	798,000	1.00
Dome Mines	169,686	542,600	1,889,201	3.48	11.10	953,334	1.00
Wright-Hargreaves	140,520	266,352	1,631,341	6.10	11.50	825,000	0.15
Sylvanite Gold	43,437	91,621	703,010	7.67	16.18	131,980	0.04
Howey Gold	41,702	211,552	711,175	3.30	17.00	....	......
Coniarum Mines	36,278	130,585	649,175	4.98	17.90	....	......
Siscoe Gold	35,936	55,675	345,001	6.20	9.60	....	......
Kirkland Lake Gold	28,315	52,628	412,832	7.85	14.55	....	......
Totals	1,936,733	4,644,657	$21,883,928	$4.71	$11.29	$14,070,558	......
			21,223,410	4.57	10.96	13,650,338(*f*)	

South African Mines

	Production		Expenses			Dividends	
	Oz. of Gold	Tons of Ore	Total	Per Ton	Per Oz.	Total	Per Share
Government Gold	1,129,872	2,435,000	£2,081,677	17/1	37/1	£1,260,000	4/6
Crown Mines	986,329	3,136,000	3,100,000	19/9	63/–	660,144	7/–
New Modderfontein	805,560	1,965,000	1,542,766	15/8	38/–	1,610,000	11/6
Randfontein	745,313	2,751,000	2,575,839	18/9	69/–	101,589	–/6
East Rand	501,085	1,865,000	1,977,184	21/2	78/–	75,000	–/6
New State Areas	479,205	958,000	1,082,084	22/7	45/–	302,808	4/–
Brakpan	414,539	1,138,500	1,211,855	21/3	58/–	408,000	8/–
Springs	413,688	843,000	934,040	22/2	45/–	581,250	7/9
Sub Nigel	352,624	410,000	736,134	35/10	42/–	487,500	6/6
Robinson Deep	334,457	1,158,000	1,120,619	19/4	67/–	155,052	....
Geduld Proprietary	323,616	1,012,000	824,541	16/3	51/–	493,039	6/9
Langlaagte	317,659	943,000	979,718	20/9	62/–	303,966	4/–
West Rand Consolidated	287,225	1,066,000	987,714	18/6	68/–	None	None
Consolidated Main Reef	271,140	795,000	965,868	24/4	71/–	151,542	2/6
Van Ryn Deep	268,940	753,000	806,927	21/5	60/–	299,223	4/–
Modder Deep	268,790	533,800	416,029	15/7	31/–	600,000	6/–
Modder B.	264,895	887,000	705,004	15/11	53/–	420,000	3/–
City Deep	264,018	1,021,000	1,123,807	22/–	85/–	None	None
Simmer & Jack	262,548	926,800	971,700	21/–	74/–	41,667	–/2
Modder East	255,908	865,500	899,797	20/10	70/–	186,161	4/–
Nourse Mines	248,329	827,600*	970,782	23/6	78/–	58,774	1/6
West Springs	210,498	851,800	734,833	17/3	70/–	134,475	1/6
Geldenhuis	198,843	861,900	772,963	17/11	78/–	56,666	1/–
Durban Roodepoort	183,020	565,200	690,670	24/5	76/–	56,250	1/6
Rose Deep	153,028	741,500	619,884	16/9	81/–	16,377	–/6
Witwatersrand	146,423	717,500	613,763	17/1	84/–	23,481	1/–
New Kleinfontein	124,782	611,200	543,209	17/9	87/–	None	None
Van Ryn Estate	122,488	530,500	457,895	17/3	75/–	31,250	1/3
Witwatersrand Deep	103,767	442,900	449,042	20/3	86/–	None	None
Luipaards Vlei	94,471	374,500	357,785	19/1	76/–	None	None
Transvaal Gold	60,295	190,216	226,532	23/10	76/–	21,449	–/9
East Geduld	56,003	231,700	191,060	16/4	68/–	None	None
Meyer & Charlton	49,080	206,120	186,548	18/1	76/–	None	None
Totals	10,727,656	32,691,636	£31,972,194	19/7	59/6	£8,535,861	......
			$155,338,268	$4.72	$14.43	$41,569,643(*f*)	

Rhodesian and West African Mines (*d*)

	Oz. of Gold	Tons of Ore	Total	Per Ton	Per Oz.	Total	Per Share
Cam & Motor	123,339	293,000	£305,170	20/10	49/6	£150,000	4/–
Globe & Phoenix	65,961	72,297	151,000	41/10	45/10	80,000	2/–
Wanderer Consolidated	44,968	182,651	127,500	13/11½	57/9	None	None
Sherwood Star	27,450	55,200	66,912	24/–	48/4	30,000	1/6
Ashanti Goldfields	172,683	147,104	291,782	39/9	34/–	337,500	3/7½
Taquah & Abosso	42,922	120,053	141,663	23/7	66/3	24,125	–/6
Totals	477,323	870,305	£1,084,027	25/–	45/3	£621,625	......
			$4,878,121	$5.60	$10.20	$2,797,313(*f*)	

Mines Under British Control (*d*)

St. John del Rey, Brazil....	115,473	221,800	£327,500	29/5¼	56/7	£67,598	2/-
Frontino Gold, Colombia...	37,130	36,140	105,000	58/4	57/-	7,688	1/-(*c*)
Chosen Corporation, Korea	39,349	115,100	157,061	27/-	80/-	None	None
Totals.............	191,952	372,040	£589,561 $2,653,025	32/- $7.13	61/- $13.82	£75,286 $338,787(*f*)	......

Gold Production Costs by Countries (*j*)

	No. of Mines	Production: Oz. of Gold	Production: Tons of Ore	Expenses: Total	Expenses: Per Ton	Expenses: Per Oz.	Dividends
Union of South Africa (*f*).	33	10,727,656	32,691,636	$155,338,269	$4.72	$14.43	$41,569,643
Canada (*f*).............	11	1,936,733	4,644,657	21,227,410	4.57	10.96	13,650,338
United States...........	6	775,853	5,889,190	8,541,653	1.45	11.30	2,936,003
Other British Africa (*f*)...	6	477,323	870,305	4,878,121	5.60	10.20	2,797,313
United States controlled..	3	198,877	378,565	2,245,898	5.93	11.29	1,954,390
British controlled (*f*).....	3	191,952	372,040	2,653,025	7.13	13.82	358,787
Totals.............	62	14,318,394	44,846,393	$194,884,376	$4.34	$13.61	$63,246,474

Dividend-Paying Mines for Which Cost Figures Are Not Available

	Production: Oz. of Gold	Production: Tons of Ore	Total Dividends	
United States				
Empire Star..........................	95,000	214,734	$95,000	
Golden Cycle..........................	100,000(*g*)	300,000(*g*)	264,000	
Tom Reed Gold..........................	35,000(*g*)	50,000(*g*)	180,000	
Bradshaw..........................	22,000(*g*)	270,000(*g*)	40,000	
United Gold..........................	15,000(*g*)	40,000(*g*)	48,017	
Granite..........................	15,000(*g*)	40,000(*g*)	49,500	
Totals..........................	283,000	970,000	$696,517	
British India (*d*)				
Mysore Gold..........................	96,042	182,731	£43,005	
Nundydroog..........................	79,836	123,039	63,675	
Champion Reef..........................	65,719	98,930	26,000	
Ooregum..........................	63,023	135,095	6,000	
Totals..........................	304,620	639,795	£138,680	$614,060(*f*)
Australia (*d*)				
Great Boulder..........................	73,904	120,140	£21,875	
South Kalgurli..........................	44,900	101,171	31,125	
Raub Gold..........................	25,000	30,000	50,000	
Ironbark..........................	2,000	4,118	6,000	
Totals..........................	145,804	255,429	£109,000	$490,500(*f*)
Belgian Congo (*h*)				
Kilo-Moto..........................	170,003	(*i*)	$540,154	
Grand Lacs..........................	36,940	(*i*)	38,920	
Totals..........................	206,943		$579,074	
Other British Africa (*d*)				
Lonely Reef..........................	38,264	255,675	£57,895	
Rezende..........................	32,557	76,400	37,500	
Totals..........................	70,821	332,075	£95,395	$439,277(*f*)
Canada (*e*)				
Pioneer..........................	30,000	34,000	$155,840	$151,000(*f*)
Mines Which Produce Other Metals Also (*k*)				
Noranda..........................	253,363	1,012,005	$1,119,886	
Premier..........................	82,394	242,317	635,713	
Waihi..........................	75,468	223,722	£95,181	
Santa Gertrudis..........................	32,422	379,954	97,088	
	443,647	1,857,998	$1,755,799 £192,269 $2,620,997(*f*)	$1,747,332(*l*)

Dividend Totals

	No. of Mines	Production: Oz. of Gold	Production: Tons of Ore	Dividends (*f*)
Other United States mines..................	6	283,000	970,000	$696,517
British India..................	4	304,620	639,795	614,060
Australia..................	4	145,804	255,429	490,500
Belgian Congo..................	2	206,943	(*i*)	579,074
Other British Africa..................	2	70,821	332,075	439,277
Other Canada..................	1	30,000	34,000	151,000
Byproduct Mines (*l*)..................	4	443,647	1,857,993	1,747,332
Totals..................	23	1,484,835	4,089,292	$4,717,760
Mines for which cost data are available......	62	14,318,394	44,846,395	63,246,474
Grand total..................	85	15,803,229	48,935,687	$67,964,234

(*a*) Adjusted expenses to cover copper-silver operations.
(*b*) Total per-ton cost, including copper-silver.
(*c*) On preferred stock only.
(*d*) Figures in British pounds, which averaged about $4.50, United States currency, in 1931.
(*e*) Figures in Canadian dollars, which averaged about 97c., United States currency, in 1931.
(*f*) After converting to United States currency.
(*g*) Estimated.
(*h*) Figures in Belgian francs, converted to United States currency at 2.78c. per franc.
(*i*) Not available.
(*j*) Dividend-paying mines or mines for which cost data are available only.
(*k*) Gold represents at least 25 per cent of the total value of the output.
(*l*) Two-thirds of dividends paid have been credited to gold production, as this is roughly the importance of the gold output of the combined companies compared with that of other metals.

19,500,000 oz. in 1929. It will probably be 22,800,000 oz. in 1932, thereby exceeding the record of 22,700,000 oz. set in 1916. I have collected some figures covering the larger individual gold mines. They show that 85 of these mines produced 15,803,227 oz. of gold, or about 75 per cent of the total gold output, from 48,935,690 tons of ore, and paid $67,964,234 in dividends. These figures are for the most recent fiscal year available (in most cases, the year ended June 30, 1931, or Dec. 31, 1931). They show, therefore, that for three-quarters of the world's production, dividends averaged $4.30 per ounce of gold recovered, or $1.40 per ton of ore treated. The average yield of this ore was 0.323 oz. gold to the ton, or about $6.60 per ton.

Figures covering the cost of production are not available for all of these mines, but I have compiled costs covering 62 of them. The average cost of production for the 62 mines, which produced 14,318,394 oz. of gold from 44,846,393 tons of ore, was $13.61 per oz. of gold recovered, or $4.34 per ton. The 62 mines paid dividends of $63,246,474, which means that the dividend per ounce was $4.42, and per ton of ore, $1.41. These figures indicate that about $2.64 per ounce goes to surplus, taxes, royalties, and other miscellaneous charges. It is possible to make a rough estimate on the cost of production for the remaining 23 mines. They averaged a dividend of $3.20 per ounce of gold recovered, indicating a cost of production of about $15 an ounce.

The bulk of the world's gold production is recovered at an average profit of 25 to 35 per cent on the value of the output. Is there any other industry of like magnitude that can show a similar record? Does it not seem logical to expect a much larger production could be obtained at a lower margin of profit? That huge tonnages of low-grade ore carrying gold exist is without question. But capital is unwilling to gamble on its exploitation. Bankers want more gold, but they are not willing to furnish the money to get it. Undoubtedly, gold mining, like every other industry, has had its fakers, perhaps more than its fair share of fakers. But there are reputable gold-mine operators in the field who are attempting to raise funds for the development of promising gold prospects that are, admittedly, speculations, but which deserve a trial. If the gold supply is to be maintained, capital must be available for gold-mine prospects.

The accompanying tables, which show in detail the figures for cost and output of leading gold mines the world over, merit explanation and comment. In arriving at the cost figure, I have eliminated, where possible, depreciation and other charges. Only actual cash expenditure for operation is included. Royalties based on the profits earned or taxes on income have not been included. The figure for cost per ounce is the total operating expense divided by the number of ounces of gold produced. In the case of one mine, Shenandoah-Dives, which has a byproduct output of copper and silver, I have included only the proportionate share of the total expense that can be charged to gold production. It will be noted that calculations for certain other mines — Noranda, Waihi, Premier — could have been made on this basis, but that I have not attempted to arrive at their costs because the byproduct metals furnish a large proportion of the total revenue, and the per-ton costs would be thrown out of line.

Many of the mines are in countries that have gone off the gold standard. In Canada, for instance, the mines are obtaining $23 in Canadian currency an ounce for gold, instead of $20.67 an ounce as they formerly did. As the costs have remained the same (say, $11 an ounce) in Canadian currency, the gold mines are actually enjoying a premium. When converted into the American equivalent, therefore, the costs show a proportionate decrease. In the tables, the costs for the individual mines have been shown in the currency of the countries where they are situated; but, in converting the totals, United States currency values are used to permit comparisons between different countries. Therefore, the costs of individual mines in countries off the gold standard are really lower than shown in the table. Costs of the Lake Shore mine, for instance, are shown as $8.15 per ounce of gold produced. On the assumption that the average depreciation in Canadian currency for the entire year 1931 was 3 per cent (a reasonable assumption, inasmuch as depreciation did not start till September, and then fluctuated between 10 and 15 per cent), the Lake Shore cost in United States currency was really only about $7.90 per ton. Two groups of mines are listed in my cost tables that were affected by depreciated currency—Canada and the British African producers outside the Union of South Africa. I have assumed that the Canadian dollar was worth 97c. in United States currency and that the British pound was worth $4.50 in United States currency. To obtain the cost of any individual mine, these figures should be used. The large group of producers in the Union of South Africa were not affected, because the South African pound remained on a gold basis. In converting costs for individual South African mines into United States currency a value of $4.87 per pound must be used.

I have not attempted to show the operating costs of any of the large Australian mines, because a considerable proportion of their output comes from ore bought from leasers, and therefore the costs are disproportionally high. In addition, Australian exchange has been depreciated since early in 1931, at rates from 10 to 30 per cent below sterling, and no reliable average figure is available. The Australian dividends are paid in British pounds, however, so that the $4.50 ratio may be used in converting them into United States currency.

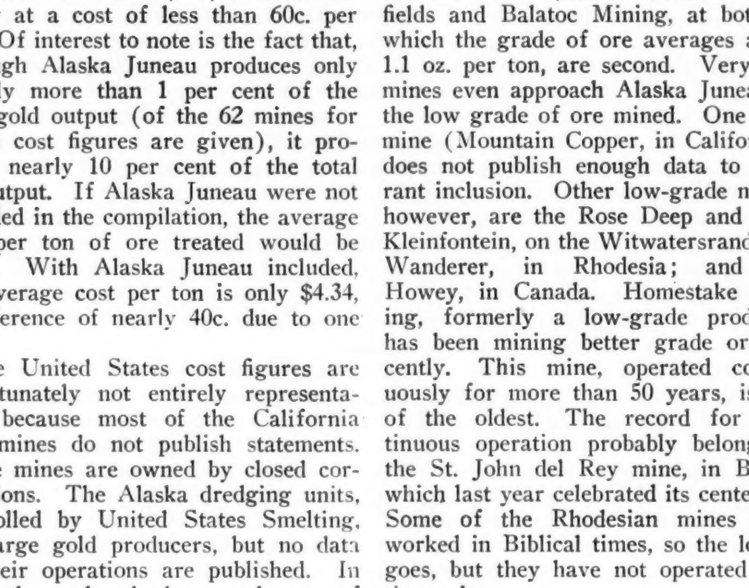
It will be seen that, measured in United States currency, the lowest-cost groups on a per-ounce basis are the British African mines (other than those in the Union), and the Canadian mines. The Ashanti Goldfields mine, on the Gold Coast, and the Lake Shore and Teck-Hughes mines, in Canada, are largely responsible for the good showing of these two groups. These three mines rank among the highest in yield per ton of ore treated, as well as in dividends per ounce of gold produced. Only one other mine, the Modder Deep, on the Witwatersrand, can compare with them in the per-ounce cost columns.

From the standpoint of cost per ton of ore treated, the United States is much lower than any other country. The reason for the remarkable record of $1.45 per ton treated is that the bulk of the United States tonnage is treated at the Alaska Juneau mine, which handles more than 4,000,000 tons annually at a cost of less than 60c. per ton. Of interest to note is the fact that, although Alaska Juneau produces only slightly more than 1 per cent of the total gold output (of the 62 mines for which cost figures are given), it produces nearly 10 per cent of the total ore output. If Alaska Juneau were not included in the compilation, the average cost per ton of ore treated would be $4.73. With Alaska Juneau included, the average cost per ton is only $4.34, a difference of nearly 40c. due to one mine.

The United States cost figures are unfortunately not entirely representative, because most of the California lode mines do not publish statements. These mines are owned by closed corporations. The Alaska dredging units, controlled by United States Smelting, are large gold producers, but no data on their operations are published. In fact, the only dredge producers of placer gold for which any figures are obtainable are the two Belgian Congo companies—Kilo-Moto and Grand Lacs. Production from dredges or other sources of alluvial gold was formerly larger than production from lode mines. At present, however, probably less than 10 per cent of the gold produced comes from dredging operations.

Much interesting information can be gleaned from the tables here presented. The Government Gold Mining property, in South Africa, is the largest individual gold producer, and it also makes the largest profits. However, it does not pay the largest dividends, because a considerable portion of its income goes to the South African Government as royalty. New Modderfontein, third as a producer, second as a profit maker, ranks first as a dividend payer. Lake Shore, the largest producer outside of South Africa, is third largest dividend payer and fifth largest producer.

Alaska Juneau ranks first as a producer of ore tonnage as well as lowest in grade of ore mined. Crown Mines is second as a producer of ore tonnage. The highest-grade mine is one of the smaller ones—Eureka Standard, in Utah, which averages 1.3 oz. per ton, or better than $26.50. Ashanti Goldfields and Balatoc Mining, at both of which the grade of ore averages about 1.1 oz. per ton, are second. Very few mines even approach Alaska Juneau in the low grade of ore mined. One such mine (Mountain Copper, in California) does not publish enough data to warrant inclusion. Other low-grade mines, however, are the Rose Deep and New Kleinfontein, on the Witwatersrand; the Wanderer, in Rhodesia; and the Howey, in Canada. Homestake Mining, formerly a low-grade producer, has been mining better grade ore recently. This mine, operated continuously for more than 50 years, is one of the oldest. The record for continuous operation probably belongs to the St. John del Rey mine, in Brazil, which last year celebrated its centenary. Some of the Rhodesian mines were worked in Biblical times, so the legend goes, but they have not operated continuously.



The Mount Isa Enterprise

Senior staff

J. M. Callow

DISCOVERY OF ORE at Mount Isa, Queensland, was a relatively recent event. Mr. Leslie Urquhart, of Russo-Asiatic, became interested in the property late in 1927, leading to absorption by Mining Trust. American Smelting & Refining acquired a minority interest in Mining Trust in the latter part of 1930, and has since undertaken the management of all technical matters. Since early in 1928 the Mount Isa company has carried on an extensive development plan, so that the mine is now one of the largest lead-zinc-silver deposits of the world, with proven ore, to a depth of 1,000 ft., amounting to about 30 million tons, developed by diamond drilling and underground work. The ore appears to consist of several lenses, parallel to one another to a greater or lesser extent, occurring in sediments, mainly shales. The upper levels, down to about 200 ft., are carbonates; below this the ore is sulphide. The mineral belt extends north and south for the length of the property, a distance of about 2½ miles. During 1931 the ore reserves, which stood at 30,554,000 tons in August, 1930, have been recalculated, and about 11,000,000 tons, assaying 4.8 per cent lead and 2.6 oz. silver, has been excluded as unprofitable at present metal prices. The reserves of profitable ore are given in Table I as follows:

Table I—Mount Isa Ore Reserves, 1932

	Long Tons	Pb, %	Ag, Oz.	Zn, %
Carbonates				
Black Star	3,162,000	8.3	2.7	...
Rio Grande	217,000	15.2	10.6	...
Black Rock	174,000	20.6	10.1	...
Mount Isa	102,000	12.2	3.2	...
Sulphides				
Black Star	15,179,000	8.3	5.1	8.9
Rio Grande	286,000	14.6	7.2	6.1
Total	19,120,000			

Present underground developments include the Urquhart or ore shaft (505 ft. deep); and, 1,650 ft. to the northwest, the man and supply shaft (350 ft. deep). The main-haulage tunnel connects the two, and is extended 1,800 ft. beyond to serve the glory holes of the carbonate ores of the Black Star lode. About midway between the two shafts, a branch, 2,650 ft. long, extends south to the sulphide ores of the Rio Grande—a total of 6,100 ft. of 8x8-ft. main-haulage tunnel. The Urquhart shaft has three 6x6-ft. compartments, two for the skips and one for ladders, pipes, and other essentials. The man and supply shaft has one cage compartment 12 ft. 8 in. by 6 ft. 6 in.; one compartment for cables, pipes, and counterbalance, 6 ft. 0 in. by 4 ft. 4 in.; and one for ladders, also 6 ft. by 4 ft. 4 in., or 12 ft. 8 in. by 11 ft. 4 in. in all, inside timbers. All water drains to the Urquhart shaft, where the main-station pumps operate. Through this shaft the ore is hoisted to the mill bins.

I and my son, M. J. Callow, were responsible for the design, construction, erection, and starting up of the surface works, comprising (1) auxiliary diesel plant of three 275-hp. National diesels and 150-kw. alternators; (2) mine compressor plant of four Bellis & Morcom two-stage compressors, each 2,100 cu.ft.; (3) main power plant of two 5,000-kw. turbo-generators, two Babcock & Wilcox boilers, and other equipment; (4) shaft equipment of one Fraser & Chalmers single-drum, semi-automatic hoist, 220-hp. motor, a 55-ft. headframe and a 6x12-ft. cage; one Fraser & Chalmers double-drum, semi-automatic hoist, 1,525-hp. motor, 115-ft. headframe, 7-ton skips; (5) mill of 2,000 tons' daily capacity; (6) smelter, with filter plant, D.&L. sinterers, blast furnaces and other equipment; (7) assay office, including crushing and sample room; (8) underground equipment, including skip pocket, electric locomotive haulage system, and station pumps; (9) warehouses, machine shops, boiler shop, roads, and railway yards.

I arrived in London on July 4, 1928. My son left London for Australia on March 2, 1929, arriving at Mount Isa about seven week later. The mill started operating on May 11, 1931, and the first blast furnace went into operation a month later. The original estimate of the time required was eighteen months from the start of excavations. The work took 24 months, although construction crews were reduced to 120 men for the last six months, because of mine-development delays. The number of men employed varied up to a maximum of 800; an average was about 400. Work included a complete change of site, and a subsequent delay of three months over smelter-site titles.

Total expenditures for equipment listed, including charges up to the date of starting, were $6,500,000. The original estimate made in June, 1930, was $6,000,000, which was therefore exceeded only by about 8½ per cent, notwithstanding changes, delays, and other unexpected contingencies. Up to the end of August, 1931, the company had expended on the entire enterprise between $17,000,000 and $18,000,000. The power house cost $109 per horsepower installed; the mill, $828 per 24-hour-ton of capacity; and the smelter, $5,000 per 24-hour-ton of concentrate smelting capacity.

When the work was first started the labor available was inferior and shift-

Mill and headframe looking north

less, as was to be expected, and much selection was necessary. Every possible line of work is unionized, and interference with business is irritating and costly. At least 22 different labor awards were involved.

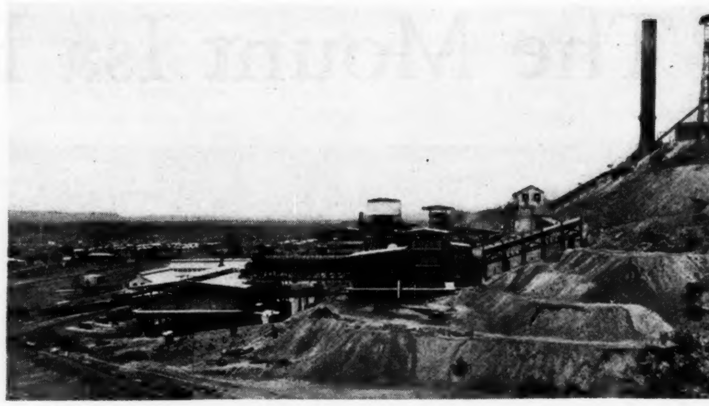
Two strikes occurred—one over beer, which lasted two or three days; and another, lasting two or three weeks, when the machinists went out over a refusal to reinstate some men discharged for incompetency in the mine. The company stood pat, and all went back to work again.

The men themselves are, for the most part, moderate and reasonable. Union elections are still run by a show of hands; and, until the secret ballot is adopted, there is no hope of the Australian worker regaining his liberty and freeing himself from the intimidation practiced on him. The political situation changed for the better in the Federal election last November, and the friends of Australia confidently believe that general conditions will improve as a result.

Ore at Mount Isa consists of carbonate and sulphide lead, and some zinc. The original plan was to mine the lead carbonates separately, and treat them in two mill units, and the sulphide lead-zinc ore in the third mill unit. This meant double-skip pockets and other complications, which, in view of the low price of zinc, have been avoided.

Continuous test work on the ground demonstrated the feasibility of mixing the two classes of ores for treatment in the proportion of 2 tons of carbonate to 1 ton of sulphide ore, and this is present practice. Carbonate ore from the glory holes and sulphide ore from the stopes are dumped together into the underground skip-loading pockets. Mixing and proportioning begins at this point and is given careful attention, both here and in the crushing plant, and in the bedding bins for the crushed ore. Intimacy and uniformity of mixture are essential for effective flotation.

Concentrator feed averages 13 per cent lead, and of this one-half is recovered on tables. The tailing, reground to 80 mesh in ball mills, is conditioned with soda ash, after which the lead in sulphide form is floated, using xanthate and aëro-float. The pulp is then agitated for 20 to 30 min. with sodium sulphide (4 to 6 lb. per ton), preparatory to floating the sulphidized lead carbonate in a second set of cells. Zinc sulphate and cyanide are sometimes introduced to depress the zinc, although mining is regulated so as to select ore that is lowest in zinc content. Some day, it is expected, or at least hoped, the zinc will be worth enough to warrant recovery. Concentrate averages 45 to 50 per cent lead, with an over-all recovery of 85 per cent. The success of combination treatment is attributed to two factors: (a) the lead carbonate is of a hard variety; and (b) the ore is relatively free from constituents that would consume sodium sulphide and make the cost excessive.



Smelter looking south

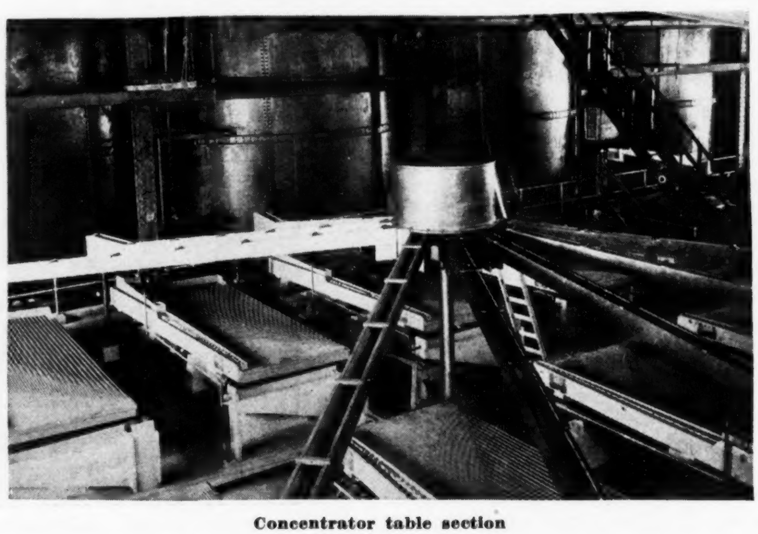
The concentrator plant consists of 20 Deister Plat-O tables, connected with the two carbonate units. The third, or sulphide unit, is a duplicate of the carbonate units, except that no preliminary tabling was expected to be practiced on the sulphide ores. For this reason the tables were placed in the rear of the fine-ore bins, to maintain uniformity of design in all the three fine-grinding and flotation departments. Eventually, when the carbonate ores are exhausted and only sulphide ore is available, the use of tables will probably be abandoned. Each fine-grinding and flotation unit consists of two 8 ft. by 60 in. Hardinge ball mills, one a primary in closed circuit with screen to 25 mesh and the other a secondary in closed circuit with Dorr bowl classifiers to 80 per cent minus 200 mesh.

Each flotation section consists of two primary and two secondary sulphide cells; eight primary and eight secondary carbonate cells, followed by two carbonate cleaners; total, 14 cells per unit. The cells are all 15-ft. Callow-McIntosh machines, with 9-in. rotors. Perforated rubber covers are used, and have proved satisfactory with 1 to 2 lb. air. The feed (Dorr bowl overflow) is thickened before flotation in 2,300-sq.ft. Genter thickeners (one to each unit), and the concentrates in 1,300-sq.ft. machines (one to each section). Thickened concentrate is stored in a 12x12-ft. Goldfield agitator, and periodically pumped over to similar storage tanks in the filter plant at the smelter. The total distance pumped is 850 ft., through a 3-in. pipe line, against a maximum static head of 30 ft.

Crude ore is dry-crushed to minus ½ in. with two 5½-ft. Symons cone crushers in closed circuit with Hummer screens, preceded by two 24x36-in. Blake crushers. The Urquhart shaft skips deliver direct into the bins ahead of this plant. The mill is on the west slope of the hill, the smelter is on the east slope, and the ore shaft is at the top, midway between the two plants.

The dry-crushing plant has a capacity of 250 tons per hour. Trouble with dust was expected, and the plant was fitted throughout with a complete in-draft dust-collecting system, using cyclones followed by bags for collecting the dust. At times the ore is wet, and the dust-collecting plant can then be shut down; at other times, when the ore is dry, it is essential.

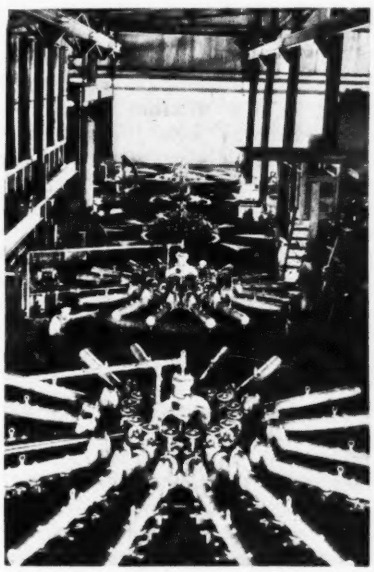
Filtering the concentrates is done at the smelter in three 12x12-ft. Dorrco filters. Following the filter plant are three 48x396-in. D.&L. sintering machines (and space for a fourth); 48x180-in. Bunker Hill type blast furnaces (and



Concentrator table section

space for a third); four 50-ton lead kettles; and two Newnam casting wheels and pig pullers. Sintering-machine and blast-furnace gases, discharged into a common flue, pass through a spray chamber and cooling flues to a Cottrell plant, thence to two 132x44-in. induction fans having a capacity of 125,000 cu.ft. per minute each, and thence to atmosphere through a 15x150-ft. brick-lined steel stack.

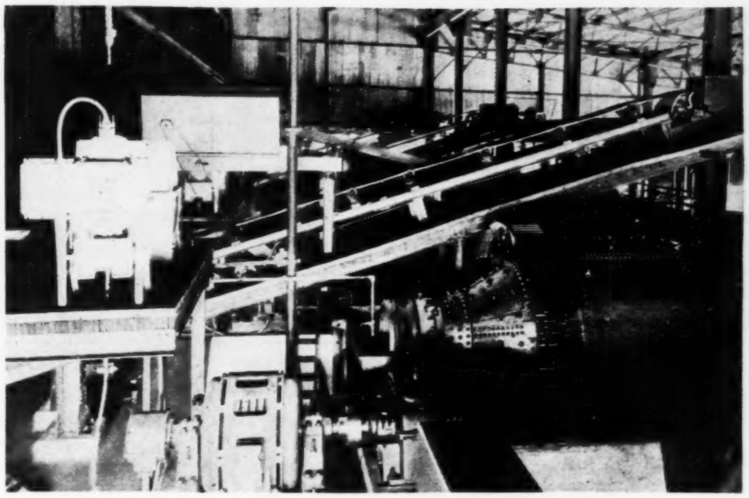
Coke, limestone, and iron flux are handled through a railroad track hopper, crusher, and conveyor system to steel storage bins. That sinter not going direct to the furnaces goes by steel-pan conveyor likewise to the same battery of bins. The storage bins have capacities for the several ingredients as follows: (1) coke, 2,000 tons; (2) ironstone, 500 tons; (3) sinter, 600 tons; (4) limestone, 400 tons; (5) slag (granulated and shells), 1,000 tons; (6) D.&L. fines, 2,000 tons; (7) balloon-flue dust, 1,200 tons; (8) coke breeze, 200



Pulp and concentrate thickeners

tons; total 7,900 tons. The bins for items 1, 2, and 3 are discharged by means of Leviathan belt-feeders, operated from and delivering into Anderson auto-weighing electric charge cars, which are run directly over the blast furnaces to discharge their load. They can carry up to three tons of charge, plus the necessary coke. The dust from the Cottrell plant hopper conveyors discharges into a partly submerged spiral-screw mixer, inclosed in a dust-tight housing. Sufficient water is added here to sluice it to a 30-ft. Dorr thickener. The mud is pumped over to the filter plant and worked off continuously by mixing it with the incoming concentrate from the mill.

The D.&L. feed consists of concentrates (47 per cent lead and 9.2 per cent sulphur), Cottrell dust, and wind-box clearings, the two totaling 57 per cent; return sinter fines, 15 per cent; granulated slag, 23 per cent; crushed limestone, 5 per cent. A total of about



Ball-mill grinding section

625 tons per day is being handled in the three machines, producing about 490 tons of finished sinter, which assays about 34 per cent lead and one-half of 1 per cent sulphur.

Items 4, 5, 6, 7, and 8 are drawn off in their proper proportions, by automatic feeder-conveyors, into a conveyor and elevator system delivering the mixture into a 10-ton dry hopper fitted with a variable-speed traveling belt feeder, and discharging into a single-shaft, 16 in. by 16-ft. knife-blade mixer making 50 r.p.m. The cake from any one of the three Dorrco filters is conveyed to the head of this same mixer, and the wet and dry ingredients are there intimately incorporated in any desired proportion by varying the speed of the dry-hopper feeder. A conveyor fitted with automatic scales takes this mixture over to the D.&L. feed hoppers. En route is a 600-ton storage bin, to which the mixture, in an emergency, can be diverted and afterward reclaimed.

Blast-furnace feed consists of 96 per cent sinter plus 2 per cent by weight of ironstone, and about an equal quantity of dross. Coke amounts to about 12 per cent, by weight, of the charge. The two furnaces are handling about 220 to 225 long tons of charge each per day.

The pig lead assays 99.5 per cent lead; 50 to 80 oz. silver; 0.118 per cent antimony; 0.017 per cent arsenic; 0.003 per cent bismuth; and 0.128 per cent copper. It is shipped in 20-ton cars to Townsville, thence by steamer to the company's refinery at Northfleet, on the Thames, England. The refined lead assays 99.994. Present output is about 3,750 tons of lead per month, but it is being increased to 5,500 tons by the addition of another blast furnace, three more sintering machines, and another unit to the Cottrell plant.

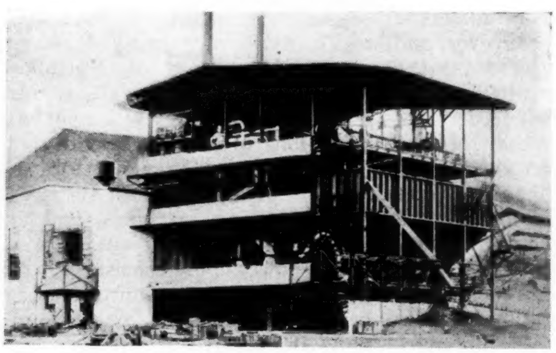
The power house consists of two 5,000-kw. units. Total requirements to date being about 3,000 kw., only one of these units is operated at a time.

Pulverized coal is used for fuel. It is received from Bowen (on the coast, 700 mi. distant) in bottom-dump cars, which discharge through a grizzly into a track hopper, thence through spiked rolls to be reduced to minus $\frac{3}{4}$ in., and by Hunt conveyor to bunkers, or, if they are full, to a stockpile. The crushed coal is recovered as required by drag-line scraper. This method of piling and recovering is satisfactory, and no

Pneumatic flotation cells

trouble has been experienced from overheating. Coal costs 40s. per long ton at Mount Isa. It is dry, easily pulverized, and of good quality, running 12,500 B.t.u.

The equipment comprises two Babcock & Wilcox marine-type water-tube boilers, each having 8,160 sq.ft. heating surface, evaporating 62,500 lb. per hour, and making steam at 270 lb. per square inch working pressure and 750 deg. F. superheat; two 16,000-sq.ft. air preheaters, and fans; two No. 6 Fuller pulverizing mills, and 6,000-cu.ft. exhaust fans; two 72x110-ft. steel stacks; two Fraser & Chalmers turbines, direct-coupled to 5,000-kw. Witton alternators, which are 3-phase, 50-cycle, 3,300-volt, 3,000-r.p.m., and air-cooled; two Hick-Hargreaves 4,550-sq.ft., surface condensers, with duplicate circulating and extraction pumps; two Hick-Hargreaves feed-water heating, deaërating, and evaporating plants and the necessary pumps; one 188-hp. Ruston & Hornsby oil engine, direct-coupled to a 125-kw. alternator (440-volt, 3-phase, 50-cycle, 300-r.p.m.) for starting up and auxiliary purposes.



Power plant

The turbine plant is served with a 15-ton single-motor crane. The building is of steel, covered with Fibrolite on sides and roof. Brick was used in the construction of the switch room. The area covered by boilers, turbines, and switch room is 157x76 ft., or about 12,000 sq.ft.

For July, 1931, the total power delivered at the various substations was 2,053,000 kw.-hr. at a cost of 0.57d. per kilowatt-hour. Of this, 59 per cent was for fuel; 31 for labor; and the balance for incidentals. Maximum load was 3,950 kw.; minimum, 2,247 kw.

The auxiliary diesel and compressor plant and the man hoist are in interconnecting buildings at the man and supply shaft. The diesel plant contains three National oil engines approximating 750-hp., which are direct-coupled to three 150-kw. alternators. They were erected hurriedly in July, 1930, to furnish power for electric mine pumps and continued to be used for this and other subsidiary purposes until the main power house went into steady operation in January, 1931. They are completely interconnected with the main power lines throughout the camp and are maintained as standbys against possible stoppages in the main power house

The compressor plant, furnishing air at 100-lb. pressure for the mines, comprises four two-stage Bellis & Morcom units of 2,100 cu.ft. each, and two 790-hp. synchronous motors (3,300-volt, 231-r.p.m.). Each motor drives two compressor units direct-coupled to either side of the motor by flange couplings. To shut down a single compressor unit, the bolts are removed from one of the couplings. Usually, two units are sufficient, but three are sometimes necessary.

Two 72 in. by 26-ft. air receivers are used. The air is distributed throughout the mine in a 12-in. main down the man shaft and thence along the main haulage drifts. Intake air is filtered through 36 sq.ft. of Midwest air filters.

The man hoist is a single-drum machine, counterbalanced. The ore hoist has double drums for operating 7-ton skips. Operation is semi-automatic—the man hoist by pushbutton, by the operator riding the cage, and the ore hoist by pushbuttons at the skip-loading pocket. At a moment's notice they can both be changed to manual control.

Both hoists were supplied by Fraser & Chalmers, and all the electrical gear was furnished by the British General Electric Company, Witton, England. The installation has given satisfactory service, and constitutes a fine sample of engineering in every respect.

Compressor plant, power house, hoists, and mill all went into service with less than the usual mechanical troubles. The power house had only one brief shutdown, of a few minutes. At the compressor plant some bracing against vibration of the air-delivery mains was necessary. The hoists gave no cause for anxiety, but some changes were necessary on the skip-dump pockets at the Urquhart headframe, on account of the wetness of some of the ore.

The crushing plant and mill required no change of importance. Some pumps were overspeeded and surged, and the method of feeding and dissolving sodium sulphide was modified. High-speed agitators in the contact tanks ahead of flotation were found necessary to bring the recoveries up to the test plant results.

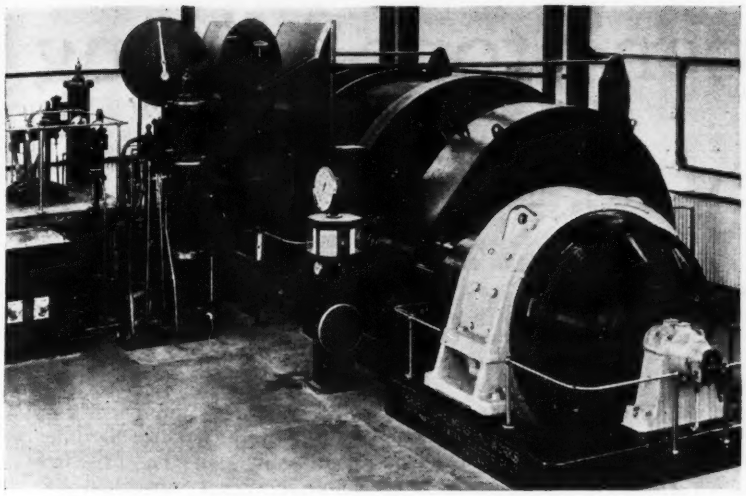
Trouble was experienced at first in pumping the concentrate over to the smelter, and also because of the sticking of the stock-tank rakes, but these difficulties were overcome by insisting on a 78 per cent pulp density at all times, and by filling the stock tanks only half full. Only 50 per cent of the concentrate to be pumped was flotation concentrate, the rest of the mixture being table products carrying 5 to 10 per cent of plus 30 mesh. High density and thick pulp were therefore indispensable.

The smelter was the cause of some delay and at one time a good deal of anxiety. In the filter plant the ribbon conveyors, for conveying and mixing the dry and wet constituents of the D.&L. feed, had to be discarded, and a belt conveyor and a relatively short knife-blade mixer substituted. The filters gave trouble until the blow-back arrangements could be modified. The quantity of Cottrell-Dorr mud proved greater than anticipated (because of hot-tops at the blast furnaces), and instead of using it merely to temper the balloon-flue dust, the original intention, it had to be pumped to and filtered with the incoming concentrates. All of the crews were green and inexperienced, and several serious breakages occurred. These, however, were only temporary and unimportant compared with the

Table II—Details of Hoists

	Man Hoist at Man and Supply Shaft	Ore Hoist at Urquhart Shaft
Depth of wind initially, ft.	350	650
Depth of wind, ultimately, ft.	950	1,315
Rope speed initially, ft. per min.	500	900
Rope speed ultimately, ft. per min.	800	1,890
Weight of men or ore, lb.	7,850 (45 men)	16,000
Weight of cage or skips, lb.	16,800	12,500
Weight of rope, lb.	4,000	5,520
Weight of counterbalance, lb.	20,700	.....
Time of winding, sec.	86.5	55
Time of decking, sec.	15	10
Motor in generator set	230 kw. 3,300 v., a.c.	1,175 kw. 3,300 v., a.c.
Generator in set	150 kw. 460 v., d.c.	1,070-1,660 kw. 500 v., d c
Hoist motor	220 hp. 460 v., d.c.	1,525-2,200 hp. 500 v., d.c
Diameter of rope, locked-coil type, in.	1½	1½
Diameter and length of drums, ft.	11x10	11x5
Diameter and width of brake path, ft., in.	12x 6½	12x13
Diameter of drum shaft, in.	14	15
Drum speed, r.p.m.	25.4(a)	60
Motor speed, r.p.m.	650	480
Gear ratio	24.4 to 1(a)	8.75 to 1
Size of building, ft.	55x35	71x41
Headframe, height to sheaves, ft.	55	115
Headframe, diameter of sheaves, ft.	12	14

(a) The motor-pinion shaft on this hoist is reversible in its bearings, bringing into play a second set of gears of a higher ratio, whereby the hoisting speed could be reduced to 350 r.p.m. when necessary to raise or lower the 8-ton electric haulage locomotives.



Semi-automatic ore hoist, 7-ton skips in balance; shaft collar to loading pocket, 650 ft.

troubles experienced with accretions in the blast furnaces.

At first, the feeding arrangements were blamed; then the composition of the charge; but eventually the nature of the sinter being made was found at fault. It was soft, too easily fusible and with too many fines, for which single, instead of double, sintering was blamed. After three weeks of harrowing experience, changes were made in the smelter personnel, H. A. Nichols being put in complete charge of the furnaces, and L. K. Jacobsen consenting to run the sintering machines and filter plant, in addition to his regular duties at the mill. O. H. Woodward, from Port Pirie, also came up to help and advise.

Conditions gradually improved. Six weeks later R. F. McElvenny, of the A.S.&R., accompanied by W. P. Mee, arrived at Mount Isa to contribute from their experience toward an increase of output. At this time about 2,500 tons of lead per month was being produced. By February the output had increased to around 3,750 tons. Messrs. McElvenny and Mee recommended the immediate installation of the third blast furnace and another sintering machine in the spaces already provided, to be followed by two more sintering machines and an addition to the Cottrell plant. This additional equipment is expected to be in operation by July, 1932, when the output is expected to reach 5,500 to 6,000 tons lead per month from the three furnaces.

Explanation of the formation of accretions in the upper part of the blast-furnace charge column is to be found in the fact that of the total lead in the concentrates two-thirds or more is lead carbonate, which softens and fuses at the low temperatures at the top of the charge column and there forms a pasty mass, even when apparently well-sintered material, with sulphur down to 2 per cent or less, was used. The solution of this problem was ultimately found to be the addition to the sinter feed of high-fusion diluents, the slag and limestone, which were otherwise a part of the blast-furnace charge, being used for the purpose. The slag was first granulated and the limestone crushed to minus ¼ in. Thus, Port Pirie practice of sending to the blast furnace a charge consisting solely of sinter and coke was followed.

Mr. Jacobsen maintained that only the sulphur in the form of iron pyrites is of use in producing the porous but hard—and low—sulphur sinter so essential to good blast furnace operations. This was accidentally confirmed in November. Results in this month were inferior to those in October. Because of unusual flow of water in the mine, about 30 tons per day of a certain ore that formed part of the mill mixture in October was not mined in November. This particular ore was found to be high in iron pyrites, and although sulphur in the mill feed was as high as previously, it was not sulphur in the form of iron pyrites. Definite agreement was also reached that double sintering offers no benefits, and that, when conditions of feed composition are correct, single sintering will give as good a product as will double sintering at Mount Isa or under parallel conditions.

The original estimates of direct working costs on a basis of 2,000 tons per day, made in December, 1930, follow:

Table III—Direct Working Costs

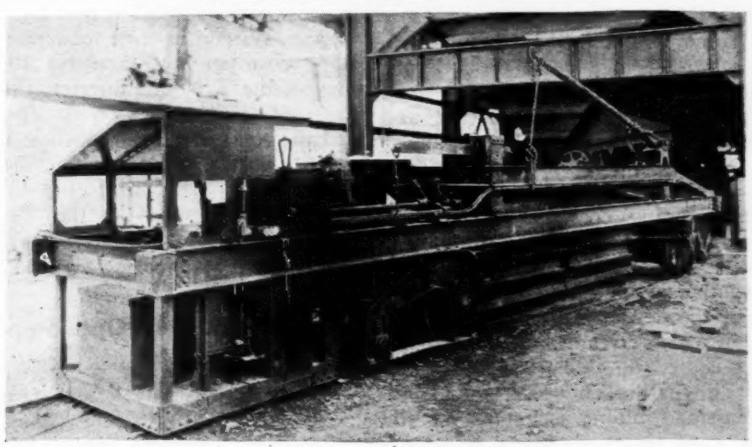
Estimated on 2,000 Tons Per Day

Milling — 2,000 tons crude ore per day	$1.50
Smelting — 400 tons concentrate per day	1.76
Mining and underground	1.63
Mount Isa overhead	0.36
Transportation, refining, and sale of bullion	2.28
	$7.53

To date, with two out of the three mill units running, the tonnage has been averaging about 1,200 per day. Notwithstanding this restricted tonnage, the estimates have been already realized. Total cost are 41s. Australia, equivalent to 32s. British, or $5.92 at present exchange rates.

For this tonnage, about 1,000 men are directly employed, distributed as follows: underground, 260; treatment plants, 320; electrical men, 52; workshops, 175; power house, 24; community work, 65; general staff and surface, 133; total 1,029.

Auto-weighing charge car and electric locomotive



Mine Boarding-House Efficiency

MECHANICAL EQUIPMENT provided for its boarding house by Hudson Bay Mining & Smelting, northern Manitoba, is of considerable interest in that it has greatly lowered the cost of catering to the men. It includes electric ovens for baking; bread, cake, and pie mixers; meat choppers; and, last but not least, a potato peeler, which, according to R. E. Phelan, general manager, has performed remarkably well. Before the company purchased the mechanical peeler, 15 men were required, working continuously, to peel the potatoes necessary to supply the crew then engaged, whereas with it one man working one shift per day is able to do all the peeling necessary. It also improved the potato recovery, it seems, because 25 per cent more of the potato by actual weight was saved with it than when the peeling was done by hand.

Cost of Open-Stope Mining

Morris J. Elsing

OPEN-STOPE MINING is the most ancient of all underground mining methods. As a matter of fact, it was used in prehistoric time. The cost per ton of mining, however, is a matter of record only in our most modern literature. The first textbook on mining, Agricola's "De Re Metallica," published in 1556 and translated by Mr. and Mrs. H. C. Hoover in 1912, mentions open-stope mining. Agricola gives the economics of mining little consideration other than to say that it is better to invest in twelve mines than in one and that the discriminating miner assays the ore and determines if the vein is too narrow and hard or too wide and soft to be profitable. For 200 years "De Re Metallica" was the leading textbook on mining, but not once is the cost of mining mentioned.

The ore tonnage annually produced by open-stope mining has been estimated at more than 31,000,000. In the production of the greater part of this the stoping cost per ton varies less than by any other method. Slight variations that exist are due partly to ground conditions and partly to variations in the application of the method itself. Open-stope mining is a cheap method. Costs lower than it permits are obtained only with modifications of the shrinkage method as applied in Alaska and by the different caving methods used in the United States. In a few instances low costs cannot be obtained by this method, mainly because of adverse ground conditions where the orebody is very irregular and requires much sorting and an excessive amount of development work.

In addition to being cheap in point of direct operating costs, the open-stope method has the added advantage of requiring the smallest outlay for plant and equipment. If the deposit is flat, most of the development is in the orebody, in which circumstance little or no money is tied up in barren drifts and raises and in broken ore.

Open-stope mining is applied in different ways under a variety of conditions. The definition of the method is exactly what the name implies—the stope is mined out and left open. If it needs support, pillars are left at regular or irregular intervals. If support other than a few stulls is required, the stope ceases to be classed as an open stope.

Variations of the method are determined to a greater or less extent by the inclination, size, and shape of the orebody. Two distinct variations are the stope-and-pillar method and the glory-hole or mill-hole method, of which, in turn, sublevel stoping is the most important variation.

The lead-zinc deposits of the Central United States are worked almost entirely by open stopes with or without pillars, as necessity demands. Many of the mines in the Michigan Copper Country are mined by open stopes of the room-and-pillar type, as are some of the iron mines of Michigan and Minnesota. The method is also used in the Eastern and Southern States. Its application in the Western United States has been confined to the smaller ore deposits. The varying cost of mining will be considered with respect to groups segregated on the basis of geographical location and as to whether or not the method is the more common open-stope method or the sublevel variation.

Tri-State Costs—Table I shows the costs of production in the mines of the Tri-State district and of Southeast Missouri. The costs are closely similar. Stoping costs this group 60c. per ton, and the total cost of ore delivered to the surface is only 90c. per ton. Average output per man underground is nearly 9 tons per shift. About three-quarters of a pound of powder was required per ton of ore produced.

Wisconsin Costs—Table III shows the cost of production at four zinc mines in the Wisconsin zinc district. The labor cost per ton is about 10c. less than in the Tri-State district; the stoping cost is 40c. per ton or 20c. less; and the total cost of production is 70c., against 90c. per ton for the Tri-State district.

The ore deposits in the Tri-State district, Southeast Missouri, and in the Wisconsin zinc district occur in beds in limestone and shale. In many occurrences the ore bed is sufficiently thick to allow of stoping by benching. The ore generally drills and breaks easily. Mucking is done by hand shoveling, by scrapers, and by mechanical shoveling machines. Hand shoveling is done at contract prices which vary from 14.5 to 26c. per ton, depending upon the length of the tram and other variable conditions. In the Tri-State district, hand shoveling into cans is considered to be the most economical method of loading.

Michigan Copper Country Costs—The cost of mining by open stopes in the Michigan Copper Country is taken from U. S. Bureau of Mines Bulletin No. 306 and from Information Circular No. 6193. The mines are denominated as Mine B and Mine C. After the ore was hoisted, it was hand-sorted and 7.69 per cent and 6.23 per cent, respectively, were removed as waste. This sorting operation on surface is rightly a part of the treatment, and, therefore, mining costs have been recalculated on the basis of the tonnage hoisted. Mine B is representative of large open stopes with pillar support and Mine C of long, narrow, open stopes supported by narrow pillars. The recalculated costs are shown in Table IV.

The ore occurs in beds of amygdaloid which dip from 30 to 40 deg. It is usually hard to drill and break. The ore beds vary from 5 to 18 ft., but are occasionally 50 ft. thick.

Iron Mine Costs—In Table V costs are given for open-stope mining of iron ore on the Marquette range and at Mineville, N. Y.

The ore at the Marquette range iron mine (Table V) is tough and hard to

Table I—Open-Stope Mining: Stope-and-Pillar Method

Cost per Ton

Item	Mine No. 8, S. E. Missouri. I. C. 6160(c)	Mine No. 1, Tri-State District. I. C. 6113	Acme Mine, Waco, Tri-State District. I. C. 6150	Mine No. 3, Tri-State District. I. C. 6174	Barr Mine, Tri-State District. I. C. 6159	Mine No. 2, Tri-State District. I. C. 6121	Hartley Grantham Tri-State District. I. C. 6286	Average
Stoping								
Labor	$0.368	$0.598	$0.310	$0.426	$0.310	$0.392	$0.343	$0.392
Supervision	0.030	0.026	0.044	0.027	0.026	0.045	0.037	0.033
Explosives	0.072	0.110	0.072	0.117	0.103	0.157	0.107	0.105
Timber	.....	.....	.....	.....	.....	.....	.....	.....
Air, drills	.....	0.127	.....	0.075	0.066	0.114	0.052	0.086
Power	0.046	0.041	0.072	.....	0.014	.....	0.006	0.036
Miscellaneous	0.033	0.083	0.042	.....	0.051	.....	0.008	0.043
Total stoping	$0.549		$0.540(b)	$0.645	$0.570	$0.708	$0.553	$0.596
Development	0.045	.....	.....	.....	.....	.....	.....	.....
Transportation	0.205	.....	0.155	.....	0.217	.....	0.159	.....
General	0.075	.....	0.021	0.162	0.043	0.165	0.049	.....
Miscellaneous	0.012	.....	0.036	0.194	0.032	0.120	0.020	.....
Total	$0.886	$0.985(a)	$0.752	$1.001	$0.862	$0.993	$0.781	$0.894
Tonnage	168,089	68,770	364,285	132,384	90,688	87,563	60,282	
Year	1928	1928 6 mos.	1928	1927	1929 4 mos.	1928 9 mos.	1929 6 mos.	

(a) Includes development and transportation. (b) Includes development. (c) Reference U. S. Bureau of Mines Information Circular.

This article is the ninth in a series on the cost of mining in the United States.

Table II—Statistical Data

Mine	Powder per Ton Stope	Powder per Ton Total	Tons per Man-Shift Stope	Tons per Man-Shift Underground	Tons per Man-Shift Total	Per Cent Labor	Per Cent Supplies
S. E. Missouri	0.46	0.55	17.0	9.67	....	72	28
Mine No. 8, S. E. Missouri	0.57	0.63	18.2	9.14	....	76	24
Mine No. 1, Tri-State district	....	0.75	10.2	5.91	....	63	37
Mine No. 3, Tri-State district	....	0.87	....	9.54	9.2	65	35
Acme, Waco, Tri-State district	....	0.59	12.6	7.68	....	60	40
Barr Mine, Tri-State district	....	0.80	16.0	9.02	8.6	55	45
Mine No. 2, Tri-State district	....	1.27	12.4	8.93	....	58	42
Hartley Grantham, Tri-State district	....	0.74	16.3	10.74	10.4	64	36
Average		0.78	14.7	8.83	....	64	36

Table IV—Michigan Copper Costs

	Cost per Short Ton Mine B	Cost per Short Ton Mine C
Stoping	$0.460	$0.578
Development	0.182	0.356
Transportation	0.480	0.449
General	0.007	0.045
Total	$1.129	$1.428
Pounds powder per ton	0.92	0.91
Board feet timber per ton	0.32	5.36
Tons per man-shift	7.10	6.90
Tonnage	791,961	1,151,557

Table III—Wisconsin Zinc District Costs, 1927 *(a)*

	Mine No. 1	Mine No. 2	Mine No. 3	Mine No. 4	Average
Stoping					
Labor	$0.269	$0.320	$0.297	$0.294	$0.295
Supervision	0.020	0.018	0.022	0.020	0.020
Explosives	0.073	0.081	0.086	0.088	0.082
Timber	.....	.....	.....	.....	.....
Air, drills	.....	.....	.....	.....	.....
Power	.....	.....	.....	.....	.....
Miscellaneous	.....	.....	.....	.....	.....
Total stoping	$0.362	$0.419	$0.405	$0.402	$0.397
Development					
Transportation	0.186	0.162	0.189	0.152	0.172
General					
Miscellaneous	0.115	0.132	0.177	0.091	0.129
Total	$0.663	$0.713	$0.771	$0.645	$0.698

(a) *Mining and Metallurgy*, July, 1928.

Table VI—Open-Stope Mining Costs Glory-Hole or Mill-Hole Method

Item	Mascot, Tenn. A.I.M.E. Vol. 72	Mascot, Tenn. I. C. 6239	Mary Isabella, Tenn. I. C. 6397
	Per Ton		
Stoping			
Labor	$0.318	$0.130	$0.270
Supervision	.....	.....	0.022
Explosives	0.059	0.045	0.076
Timber	.....	.....	.....
Air, drills	.....	0.042	0.177
Power	.....	.....	.....
Miscellaneous	.....	0.005	.....
Total stoping	$0.377	$0.222	$0.545
Development	0.133	0.053	0.355
Transportation	0.174	0.278	0.714
General	0.100	0.086	0.154
Miscellaneous	.....	.....	0.060
Total	$0.784	$0.639	$1.828
Tonnage	212,990	528,626	108,519
Year	1923 6 Mos.	1929 10 Mos.	1928
Explosives, lb.			
Stoping	0.56	0.50	0.42
Total	....	....	0.78
Tons per man-shift			
Underground	....	10.83	3.58
Total	8.45	....	2.79

Table V—Iron Mine Costs

	Cost per Short Ton Marquette Range I. C. 6138	Cost per Short Ton Mineville, N. Y. I. C. 6092
Stoping		
Labor	$0.458	$0.144
Supervision	0.023	0.013
Explosives	0.093	0.109
Air, drills, steel, repairs	0.093	0.101
Timber	0.002	.....
Power	0.006	.....
Miscellaneous	0.010	0.003
Total stoping	$0.685	$0.370
Development	0.194	0.145
Transportation	0.217	0.628
General underground	0.160	.....
Miscellaneous	.....	0.023
Total	$1.256	$1.166
Year	1928	1927
Pounds of powder per ton		
Stope	0.62	0.71
Total	0.80	0.83
Board feet timber per ton		
Stope	0.20	....
Total	0.40	....
Tons per man-shift		
Stope	8.48	12.47
Total underground	6.85	8.38
Percentage of costs		
Labor	65	60
Supplies	35	40

Table VIII—Presidio Mine Costs

Stoping	Per Ton
Labor	$1.442
Supervision	0.145
Explosives	0.177
Timber	0.025
Air, drills, steel, repairs	0.430
Power	.....
Miscellaneous	0.056
Total stoping	$2.276
Development	1.065
Transportation	0.533
General	.....
Miscellaneous	0.127
Total	$4.001

Pounds powder per ton: stopes, 1.18; total 2.
Tons per man-shift: stopes, 2.18; underground, 1.39; Total, 1.29.
Percentage: Labor, 73, supplies, 27.0.

drill but stands well. The hanging wall is slate which slacks, to prevent which a little ore is left in the roof. Rooms are 25 ft. wide and 25 ft. high and floor pillars are from 15 to 25 ft. thick. Rooms are driven by breast stoping, and the broken ore is scraped into a chute or car. Stope drill holes break about 1 ton per foot of hole. Contractors are paid from 32 to 53c. per short ton of ore delivered to the chute or cars, this including breaking and scraping. The contractor pays for his explosives, carbide, and hand tools. Where hand shoveling in stopes is done, the contract price is 18.6c. per short ton.

The magnetite ore at Mineville, N. Y., occurs interstratified in gneissoid beds. The ore bed is 3 to 40 ft. thick and averages 10 ft., and dips 20 to 30 deg. Pillars are left to support the hanging wall. Cars are loaded with hoe-type scrapers and air-operated shovels of the dipper type. Premiums are paid on the

Table VII—Open Stoping Costs per Ton: Glory-hole or Mill-hole Method, Sublevel Stoping

Item	Burra Burra, Ducktown, Tenn. I. C. 6149	Mine No. 2 Marquette, Range. I. C. 6179	Mine No. 1 Menominee Range. I. C. 6180	Hanover Bessemer, Fierro, N. M. I. C. 6402	Montreal, Wisconsin. I. C. 6369	Helena, Mont. I. C. 6402	Average
Stoping							
Labor	$0.131	$0.169	$0.219	$0.112	$0.163	$0.738	.....
Supervision	.....	0.022	0.028	.....	0.015	.....	.....
Explosives	0.049	0.044	0.080	0.057	0.072	0.178	.....
Timber	.....	0.009	0.008	.....	0.038	.....	.....
Air, drills	0.034	0.027	0.071	0.036	0.009	0.124	.....
Power	.....	0.042	.....	.....	.....	.....	.....
Miscellaneous	0.118	0.067	0.009	0.101	0.014	0.032	.....
Total stoping	$0.332	$0.371	$0.415	$0.306	$0.311	$1.072	$0.466
Development	$0.229	$0.223	$0.188	.....	$0.380	$0.377	.....
Transportation	0.386	0.133	0.154	.....	0.248	0.131	.....
General	0.145	0.171	0.046	.....	0.095	0.218	.....
Miscellaneous	0.043	0.059	.....	.....	0.052	0.147	.....
Total	$1.135	$0.957	$0.803	......	$1.086	$1.945	$1.185
Tonnage	473,292	140,000	220,000	220,000	700,000	43,323	.....
Year	1928	1928	1928	1929	1928	1929	
Explosives, lb.							
Stoping	....	....	0.55	0.40	0.44	0.88	0.57
Total	0.76	....	0.73	0.52	0.76	1.26	0.80
Timber, bd.ft.							
Stoping	....	....	0.02	....	....	....	....
Total	0.61	....	0.03	....	1.46	0.39	0.62
Tons per man-shift							
Underground	....	....	11.5	....	8.66	7.40	9.2
Total	6.08	....	....	11.3	7.95	4.20	7.4

basis of hand cars loaded and tons of ore broken in stopes. If twelve or more cars are loaded and trammed per shift, the rate is 26.8c. per short ton. The base rate of drillers is $2.88 per shift, but the men are paid at the rate of 12.5c. per ton for all tonnage broken in the stopes. Average wage in 1927 was $5.63 per shift. The miscellaneous charge includes 5.3c. for shaft extensions.

Underground Glory-hole Stoping. This method, or mill-holing, requires that ore and wall rock stand sufficiently well to allow the opening of rather large excavations without danger of serious caving. The original excavation is enlarged by blasting into it additional surrounding ore, which is drawn off through chutes below. In the sublevel stopes the same principles are employed, the only difference being that the methods of breaking the ore is a little more systematic, in that sublevels provide the working places. Sublevel stoping is essentially an underground glory-hole method. The ore is broken in the stope and falls into chutes, or to grizzly levels, where it is drawn off.

In Table VI, costs of producing ore by the glory-hole method of open-stope mining are given for the Mascot and the Mary mines, in Tennessee. Costs of sublevel stoping are given in Table VII.

Needless to say, with such low costs operating conditions must be ideal. In each of the mines for which data are given the walls are firm and sufficiently strong to allow the opening of excavations of considerable size without serious caving. The ore at Mine No. 2, Marquette range, is soft hematite occurring in ferruginous cherts and shales. At Mine No. 1, on the Menominee range, the ore is soft hematite, occurring in slate. The Ducktown ore occurs as pyrite, pyrrhotite, and chalcopyrite in metamorphosed schist and graywackes. The Fierro, N. M., ore is magnetite and occurs as a contact metamorphic deposit in limestone. The method used at this mine was introduced by Sam A. Houghton. It varies from the conventional sublevel method in that ore is broken from inclined raises rather than from horizontal drifts. The ore at the Spring Hill mine occurs in limestone at its contact with diorite. It consists of pyrrhotite, pyrite, marcasite, and arsenopyrite in a variety of lime-silicate minerals. It carries about $6 per ton in gold. The ore is extremely hard and tough, and the costs of breaking are high. Excluding the Spring Hill, the average cost of stoping for five mines which use the sublevel method is 35c. per ton and the total cost of mining is $1 per ton.

Miscellaneous Costs — The costs already presented are low, owing to the extremely favorable ground conditions. Where conditions are adverse, as at the Presidio mine of the American Metal Company, Big Bend district, Texas, high costs result. Costs in Table VIII are taken from Technical Publication No. 334 of the A.I.M.E.

The ore occurs as irregular replacements in limestone. The high costs are due to numerous adverse conditions. Both ore and the limestone are hard, as indicated by the amouut of powder used. The mine is 45 miles from the railroad. The orebodies are irregular in size and shape, necessitating a large amount of development work. Selective mining is necessary and considerable wheelbarrow work has to be done in stopes. No standard speedy methods can be employed, with the result that the tonnage per man-shift is low and the cost per ton is high.

Costs at the Cornucopia mine, in Oregon (Trans. A.I.M.E., Vol. 72), illustrate what can be accomplished in mining a narrow vein at the rate of 100 tons per day. The vein is quartz with iron sulphides containing gold and silver. The average width of vein is 5 ft. Stulls are placed in the open stopes to prevent slabbing of the hanging wall. Under average conditions in 1923 the total cost of mining, including $0.86 for development work, was $1.94 per ton. Production per underground shift was 3.4 tons. The powder used per ton was 0.96 lb., and 0.28 linear feet of timber was used per ton of ore produced.

Costs of mining by the glory-hole method are remarkable for several reasons. They are exceedingly low and are not confined to any one section of the United States. They are representative of iron, copper, zinc, and gold mines. Wages in the different districts vary considerably, and yet, if certain allowances are made for extraordinary expenses, they are more closely parallel than is indicated in Tables VI and VII. The lowest cost is that of the Mascot in 1929. The stoping cost of $0.222 per ton does not include the cost of blockholing the ore at the chutes, which item is included in transportation. With the addition of this cost to the direct stoping cost a figure very close to the other stoping costs would result.

Summary—A summary of the various group costs is given in Table IX.

Table IX—Approximate Open Stope Mining Costs, Per Ton

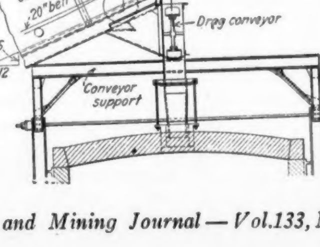
	Stoping	Tota Mining
Tri-State and S.E. Missouri districts	$0.60	$0.90
Wisconsin zinc district	0.40	0.70
Michigan Copper Country	0.45	1.25
Iron mines	0.50	1.20
Glory hole including sub-level stoping	0.35	1.00
Average	$0.45	$1.00

The approximate average costs shown in Table IX are representative of the cost of mining more than 6,000,000 tons of ore. Costs as low as these can be expected only when operating conditions are good. Extremely hard ore, small irregular orebodies, narrow veins, and many other conditions may increase the cost 200 or 300 per cent. The groups in this table show variations, but these can be explained by ground conditions. The Michigan cost is highest, and this is due largely to the hardness of the ore and the great depth of the mines. Lowest cost was obtained in the Wisconsin zinc district. The ore in these mines is very low in grade, and the mines are operated only when zinc commands a high price. For this reason, only ore that is easily and cheaply worked is mined. This results in low costs per ton but does not indicate more efficient methods or better work than is being done in the other districts where to mine ore the recovery of which was more expensive might pay.

Low costs are not confined to any one district and are possible only where ground conditions are such that cheap methods can be used. Low costs, furthermore, are not dependent upon cheap labor, but, other conditions being equal, depend mainly on efficiency of management. The labor return is nearly always commensurate with its pay.

Dust-Proof Reverberatory Charging

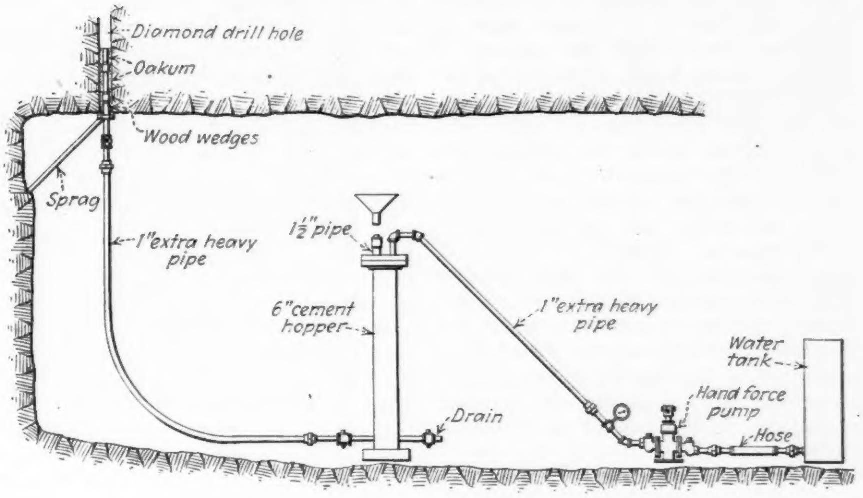
TO SAFEGUARD the health of the furnace crew, the dust-proof charging arrangement shown in the accompanying sketch has been adopted in the Carteret lead plant of U. S. Metals Refining Company. The reverberatory furnace is charged through three openings in the center of the roof by a drag conveyor and Fahralloy chutes. An inclosed belt conveyor, extending to the outside of the smelter building, feeds the drag conveyor, and the charge is not exposed in the building until it drops into the furnace. The inclosed conveyor is fed by two 24-in. Dodge conveyors, one coming from a pug mill mixing fine material and flue dust, the other from a Trojan M-2 hammer mill, where the coarser part of the feed is broken up. Although much fine material is fed to the furnace, the arrangement has proved absolutely dust-proof and has given satisfactory service.



Reducing Mine Pumping Expense

Water that enters underground workings directly or indirectly from old drill holes has been the cause of considerable trouble and expense in many mines. This article describes a simple and inexpensive method of sealing off this water, with resultant appreciable reduction of pumping expense.

C. W. Allen



Arrangement for sealing diamond-drill holes

THE Mackinaw-Gardner mine, operated by the Cleveland-Cliffs Iron Company at Gwinn, Mich., was unwatered in 1927 after a suspension of several years. A vein orebody averaging 20 ft. thick, dipping at about 45 deg., with a length of about 1,200 ft. along the strike, is now being worked. The ore is a semi-hard hematite, and the mining method is shrinkage stoping with supporting pillars. This mine is served by a vertical three-compartment shaft sunk in the footwall to the 5th level, and from there to the lower levels by a three-compartment inclined winze sunk in the orebody.

The original discovery and exploration of this orebody, unlike all others in the district, was by diamond drilling from the surface about 25 years ago. Above the orebody, and for miles around, the topography is flat swamp, with large sand areas a few feet above the swamp level. The drill holes, without exception, went through about 100 ft. of saturated sand and boulders before encountering ledge. On entering the ledge, or hanging-wall slate formation, the drill holes started to deviate from the vertical, some to such an extent that, on entering the ore, about 1,000 ft. below, they had migrated distances of over 600 and 700 ft., and the dips had flattened to from 20 to 25 deg.

More than 50 holes were drilled to delimit the ore and determine a suitable shaft location. Standpipe was usually pulled on the completion of a hole, to be re-used. This precluded possibility of effectively sealing the holes from the surface, although recently an attempt was made to do this, and two or three holes were recovered at the ledge and partly sealed by lowering quick-setting cement into the hole, to set below the ledge. The removal of standpipe was common practice 25 years ago, a completed drill hole being considered a finished exploration, without regard to the possibility of its serving later as a watercourse to the orebody and mining operations. Present-day methods are to seal the drill holes above the orebody with cement, or allow the standpipe to remain in place on completion of the hole, so that cementing may be done later.

In earlier years and on the upper levels, drill holes were sealed underground as they were encountered, by the simple method of driving wooden plugs into the holes and supporting their lower ends. As mining was carried downward and the head of water on the holes increased, to make an effective seal became more and more difficult, and the amount of water being pumped steadily increased. Other devices were tried, such as pipes in short lengths, the many couplings of which were wrapped in oakum, with a shut-off valve on the last length of pipe, and combinations of pipe, oakum, and wooden wedges. An added difficulty was the fact that the pipes needed replacement every six or eight months, because of the corrosive action of the acid mine water.

Early in 1931, two holes were encountered in ore on the 6th level, and the flow of water was cut down appreciably by the use of pipe, oakum, and wooden wedges. Then water broke through from a drill hole in the side of the inclined winze between the 6th and 7th levels, flooding the lower level, so that increased pumping capacity had to be provided. Drifting to reach the drill hole was started, and had to be lowered to a new elevation three times to follow the course of the water. The drill hole was finally located in the hard-seamed jasper hanging wall, at a point 75 ft. from where the water had first broken through in the side of the winze. The water issuing from this hole amounted to nearly 200 gal. per minute, and the hard work of trying to seal the hole by the usual methods evidently accomplished little. A concrete dam in the small drift leading to the hole was the last resort, but the 1,200 ft. head of water soon had the seams of rock surrounding the dam leaking at a rate of over 50 g.p.m..

A better method of sealing the holes had to be evolved, for three or four more of these deep holes were yet to be encountered, and the necessary pumping expense would be out of proportion to the return on the amount of ore produced. The easiest way considered of making a permanent seal would be to force cement into the hole, backing up the water, and then maintaining pressure until the cement had set. This method, with the cement or other filling material between two pressures, would force it into cracks or seams leading off from the drill hole, and insure a complete and permanent seal with a minimum of labor and material. Pressures of over 500 lb. per square inch would have to be met and conquered, and the apparatus must be easily portable.

Wilfred Tousignant, the master mechanic at the mine, ingeniously solved the problem, and to him is due full credit for the complete success of the method later described. Mr. Tousignant designed and constructed a device consisting of a hand force pump, similar to the pumps used in testing boilers, the suction of which was connected to the bottom of a 52-gal. water container. The discharge of the hand pump was connected by 1 in. extra-heavy pipe and fittings to a pressure gage, and then to a hopper made of 6-in. extra-heavy pipe, the capacity of which is about 6 gal. The top of the hopper was provided with a 1½-in. connection, with screw plug for filling, and a few inches above the bottom was placed a 1-in. connection with a 1-in. tee. On one side of this tee a release valve was added and on the other a 1-in. stopcock, which was used as a discharge line to the diamond-drill hole. All pipe and fittings were extra heavy. A scale was hung in the water container to indicate the amount of water taken by the force pump, and, therefore, the amount of material forced from the hopper to the diamond-drill hole.

A description of the use of the device to seal off the drill hole leaking through cracks surrounding the concrete dam follows: Access to the drill hole was gained by driving a small drift around one side of the dam. The pipe and wooden wedges in place in the hole from the former efforts to seal it were then removed, and about 12 ft. of 1-in. pipe, cut in 12-in. lengths, with the joints wrapped in oakum, was forced up into the hole by screwjacks. Next, the space between the pipe and the hole at the collar was filled by driving wooden wedges, meanwhile leaving the pipe running free. The pressure machine was then connected to the drill hole by an extra-heavy fitting, with the relief valve open. On closing this valve and allowing the pressure to build up through the hopper to the gage, slightly over 470-lb. pressure resulted from the head of water in the drill hole.

After draining the hopper of water by closing the drill-hole valve and opening the release valve, several hoppers of a mixture of about half cement and half water were forced into and up the hole by pumping to a pressure of about 500 lb. and opening the hopper valves and closing the release valve. In a short time the cement was being carried through cracks that opened into the side and breast of the small drift up to distances of 8 and 10 ft. from the drill hole. A hazard existed that the major part of cement would be washed away before it had time to set, so several hoppers of a mixture of bran, oats, and cement were forced into the hole. The bran and cement issued from some of the cracks at a reduced rate, but the oats lodged. The pressure to introduce the last of these mixtures was raised to over 700 lb., indicating that the desired effect of having this material fill the cracks, and stem the flow of cement until it set, had been realized. The pressure was maintained for about 10 min., after all leakage stopped; and, as cement sets rapidly under such conditions, a valve, provided at the end of the drill-hole pipe, was shut off and the machine disconnected.

A few days later a slight drip from the end of the pipe into the drill hole had ceased altogether, and an inspection of the floor of the drift leading to the hole revealed only the usual moisture. This proved that the method of sealing the hole was completely successful, shutting off not only the drill hole but any and all cracks or seams from it which might serve as waterways into the underground openings. The materials used in sealing this hole consisted of three sacks portland cement, six quarts bran, six quarts oats.

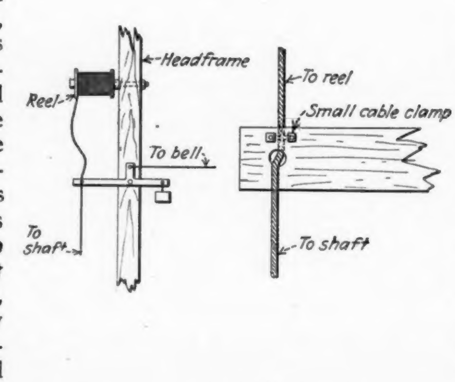
The success attendant on efforts to seal this high-pressure, fast-flowing drill hole was equaled with less labor in sealing the partly closed drill holes in other parts of the mine. Over a few weeks, the machine was taken to every drill hole that could be conveniently reached, and used with as much success as had resulted from the attempt described. A few injections of cement with enough time elapsed to allow it to set usually effected a complete seal, without the necessity of resorting to the use of oats or bran to seal off cracks. The collars of these holes were sealed in rock materials ranging from a seamed and rather soft iron ore, to a hard, brittle, badly cracked jasper or slate formation. In addition, the last of the deep holes to be encountered in mining operations was completely sealed several months ago, within two days after intersecting it in a drift.

Other ways of supplying high pressures at the drill holes than by means of the hand pump were available by tapping the mine discharge water column, or by supplying power from a small electric pump. Either of these methods may be suitable for use at other mines, but at the property here described they were discarded because of the heavy expense of piping or transmission to the many scattered drill holes, as against the simplicity and cheapness of the method employed. Undoubtedly, the use of this device will reduce pumping charges in mines in which are leaking drill holes. At the Mackinaw-Gardner mine this expense mounted so rapidly, as additional drill holes were encountered by mining operations, that either the water had to be shut off or the mine shut down. Pumping has been reduced from a maximum of 510 to 228 g.p.m., and pumping expense in nearly the same ratio, from about $2,500 to $1,000 per month.

■ ■ ■

Bell Cord Reel For Shaft Sinking

During the time a shaft is being sunk, the lengthening of the bell cord, as the depth of the shaft increases, is a constant source of trouble, writes E. W. Baker, Winkelman, Ariz. Splicing the cord with odds and ends of old cord or wire is dangerous, as one of the splices may give way just when the necessity for the hoisting engineer receiving the proper signal, complete, is vitally important. To overcome this difficulty, a cord of sufficient length to reach the bottom of the completed shaft should be wound upon a wooden reel, and the reel pivoted on a bolt a few feet above the bell crank, on the headframe. The end of the bell cord should



then be threaded through the hole in the end of the bell crank, and thence pass into the shaft. Two holes should be drilled in the end of the bell crank, as shown in the accompanying sketch, and a small cable clamp used to grip the cord against the side of the crank. The sharp edges of the holes should be rounded off and smoothed, and the holes for the clamp should be countersunk on the side opposite the nuts, so that the clamp may be pulled in far enough to grip the cord firmly. More bell cord may readily be let out by loosening the nuts on the clamp and pulling the desired amount of cord through the clamp. The nuts should then be tightened.

Sampling a Gold Placer

Washing plant used in the sampling of the Rich Hill and Weaver Creek placers; with sample boxes, and truck for hauling them from shaft to washing plant

Dwight L. Sawyer

THE Rich Hill and Weaver Creek placers, about three miles wide by six miles long, recently sampled under the direction of R. H. Moran and myself, are in southern Yavapai County, Ariz., near the town of Weaver. Since their discovery in the early '60s they have produced about two million dollars in gold, mostly from the top and sides of Rich Hill, where much of the gold has been picked up on the surface as nuggets by placer miners or nugget hunters. A former manager of the Octave mine, in the vicinity, stated that he had difficulty in holding his crew after a rain, as so many of them went nugget hunting. Many nuggets worth from \$200 to \$400 have been, and are still occasionally, found.

Weaver Creek placers have been formed by existing and older channels, which have meandered through and have reconcentrated the still older gravels of a large typical desert playa at the mouth of the creek. The thickness of these reconcentrated stream gravels varies from a few feet to more than 50 ft. They have been deposited on a false bedrock formed by the older playa gravels. Where these older gravels had been exposed for a considerable time previous to the deposition of the more recent stream gravels, the false bedrock is a caliche, and resembles a true bedrock. These recent gravels, although loose, contain many boulders. In places the plus-6-in. boulders exceed 65 per cent of the "in-bank" volume. In other areas the gravels are composed of 95 per cent minus 6-in. material, overlain with 1 to 5 ft. of clay.

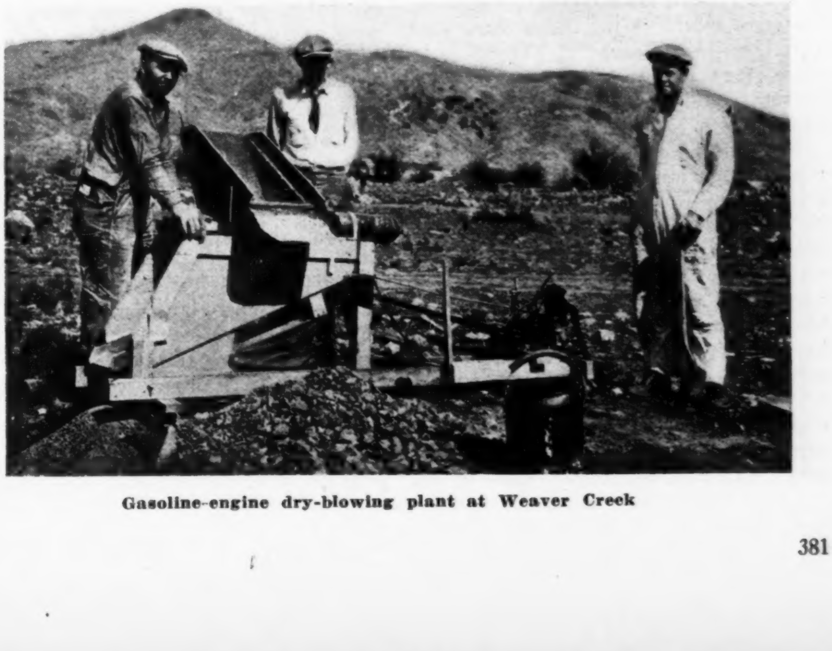
The gold, rough and bright, has an average fineness of about 925, or a value of \$19.12 per ounce. Although it varies in size from microscopic "colors" to pieces weighing over one pound, the bulk is about the size of flaxseed. The gravels contain about 1 per cent black sand.

To valuate a placer deposit such as this, containing so many large boulders, where the fine material that could be washed was such a small percentage of the total volume, required special care. Realizing this, we decided to sample the deposit by shafts, and to wash all or most of the gravel excavated. As the shafts were sunk, the plus-6-in. boulders were picked from the gravel, and the gravel from each 5 ft. of depth was segregated and washed separately. When any marked change in the character of the gravel occurred, the 5-ft. sample interval was lessened to meet the change. The average sectional area of the shafts at the point from which each sample was taken was determined by careful measurement. This average area, multiplied by the depth of the sample interval, gave the volume of the excavation from which the sample came. The value of the gold, in cents, recovered from the sample, divided by the volume in cubic yards from which it came, gave the value in cents per cubic yard of the gravel in place, or "in bank."

Shafts as sunk averaged about 3½x5½ ft., and most of them had to be cribbed. The cribbings used were 2x12-in. planks, which were cut in 3 ft. 4 in. and 5 ft. 4 in. lengths; 2x2x6-in. blocks were cut from the ends of each board, so that when in place the boards of each round of cribbing had a 6-in. bearing surface on each other. Each round of cribbing was hung from the next higher round by 1x4x12-in. nailing strips. In sinking these shafts an effort was made to keep the cross-sectional areas constant from top to bottom. When false bedrock was reached, a few inches of it was taken, and then the bottom of the shaft was further cleaned with the aid of a whisk broom and small scoop.

The shafts averaged 12 ft. deep, and the labor cost on those sunk on company account varied from \$3 to \$6 per foot. The remainder were sunk on contract for a labor cost of \$2 per foot for the first 10 ft., and \$3 per foot for the second 10 ft. At this price the individual contractor's earnings averaged \$5 per 8-hr. day.

Minus 6-in. gravel from the test shafts was shoveled into boxes holding



Gasoline-engine dry-blowing plant at Weaver Creek

Dry blower at work on placer ground

exactly 1 cu.ft., and these were then hauled in a Ford truck to the washing plant. The sides and bottoms of the boxes were constructed of 1x4-in. tongue-and-groove flooring, and the ends were of 2-in. material. They were bound around at the ends with 2-in. strips of 20-gage galvanized iron. Pieces of 2x3-in. iron were nailed on the ends, through which rope handles were attached.

The number of these boxes required to contain the minus-6-in. material from a cubic-yard excavation varied according to the amount of plus-6-in. boulders present; 1 cu.yd. (bank measurement) of this gravel, containing no plus-6-in. boulders, filled about 50 of these 1-cu.ft. boxes. This is accounted for by the swell of the gravel from its compact state in the bank to its loose state when in the boxes, and to the voids in the corners of the boxes.

To wash all the gravel extracted from the shafts, a plant that would handle six to ten yards a day was built. Four sluice boxes, 8 ft. long, 10 in. wide, and 6 in. high, were made of clear-surfaced 1-in. lumber. Instead of having butt joints, they were made so that the stream from the upper one dropped into the lower box. This was done to avoid cracks and to facilitate cleaning up small amounts of fine gold quickly. In the bottom of No. 1 sluice box was placed a 1-in. board, 4 ft. long, through which 1-in. holes had been bored on 3-in. centers. These holes were staggered, so that no part of the current could avoid passing over some of the holes.

No. 2 and No. 3 boxes were equipped with Hungarian riffles, 1½ in. high and 8 in. apart. Burlap, covered with metallic lath, was used instead of riffles in No. 4 box. The last box discharged on an apron board, or scavenger, which was 4 ft. long and 3 ft. wide, and was likewise covered with burlap and metallic lath. A hopper for washing and screening the gravel was set on the first sluice box. The gravel to be washed was shoveled from the sample bin, set next to the hopper, onto the first screen, which had 1-in. openings. Here it was washed clean of all clay by water coming from a 2-in. perforated pipe attached to the side of the hopper. This pipe was connected with the Octave Mine pipe line. The water required for the washing plant was about 50 gal. per minute.

After being washed clean on the top 1-in. screen, the oversize went to discard, and the undersize fell onto another screen having ½-in. openings. Here the gravel was again washed; the oversize discarded, and the undersize carried into No. 1 sluice box, along with the wash water. Both the 1-in. and the ½-in. screens were set at such flat angles that the oversizes had to be raked off by hand. This was done to insure that all oversize was properly washed before being discarded, and to allow for the inspection of the oversize for coarse gold.

The sluice boxes were set on standards, so constructed that the heights could be adjusted to give any desired slope to the boxes. The grades of the

Mother and son making a living on Weaver Creek

boxes were determined by trial, and set to suit the particular gravel being washed, just enough slope being given to keep the holes and riffles boiling and the black sand from packing.

The grades used in sluicing one sample when all plus-½-in. gravel was removed by the screens and when 50 gal. of water per minute was being used were as follows: 9 in. to 8 ft., for Nos. 1, 2, and 3 boxes; 4 in. to 8 ft. for No. 4 box; 1 in. to 4 ft. for the apron board. Frequent pannings were made of the tailing to serve as controls in the operation of the plant. No mercury was used in the sluice. Part of the gravel sampled contained a large amount of sticky clay, so the ½-in. screen ahead of the sluice was replaced with a ¼-in. screen. The clay lumps that passed this screen were small enough to be broken up by the water before leaving the tail of the sluice. Oversize from this screen was puddled in galvanized wash tubs, and then washed again on the screen.

The upper 5 ft. of this clayey gravel from some of the shafts carried more gold per yard than the 5 ft. immediately above bedrock. Many of the dry placers of this district owe their origin to this surface concentration, the rains having dissolved and washed away the clays, leaving the gold on the surface. Placer miners work these deposits by sweeping the surface material into piles, and then running the sweepings through their dry washes.

In cleaning up, the quantity of water entering the sluice was reduced and the material caught by the holes, riffles, and burlap was collected in a pan. This was then carefully panned to give three products: a clean coarse gold, a black-sand fine-gold concentrate, and a tailing for discard. To preserve the true character of the fine gold, the black-sand fine-gold concentrate was first dried and then spread out in a thin layer on a flat surface. The black sand, mostly magnetite, was then picked up with a magnet covered by a thin cloth sack, then dropped in a separate pile, and the operation repeated so as to recover any gold that might have been carried over during the first operation. Gold remaining after the magnetite was removed was further cleaned on white paper by blowing off the lighter materials. When the purpose was not to preserve the true character of the fine gold recovered from the black sand, it was amalgamated under water in a gold pan. The amalgam was then treated in a small beaker with a 50 per cent solution of nitric acid, until the mercury was dissolved. The fine gold recovered from the black sand by either of these methods was added to the clean, coarse gold and weighed on a balance accurate to 1/100 milligram.

The gold recovered from the various samples was put in glass vials having labels giving the following data: number of shaft; footages between which the sample was taken; volume in yards of excavation from which sample came; weight of gold in milligrams; and value of gold in cents.

To determine what recoveries were being made with the washing plant, the following test was made: A measured amount of gravel of predetermined gold content, to which a weighed amount of gold had been added, was run through

Winning gold with a hand machine

Check Test of Sampling Technique and Apparatus

Source of gold, or where recovered	Weight of Gold in Sample, Milligrams	Weight of Gold Recovered, Milligrams	Recovered Gold, Per Cent	Total Gold, Per Cent
25 cu.ft. of gravel	253	......	.....	.....
Gold added	30,553	......	.....	.....
Total amount of gold in sample	30,806	......	.....	.....
4-ft. board in No. 1 sluice box		18,530	62.57	60.12
Nos. 2 and 3 sluice boxes		11,034	37.26	35.85
No. 4 sluice box and apron board		51	0.17	0.16
Total gold recovered		29,615	.....	96.13

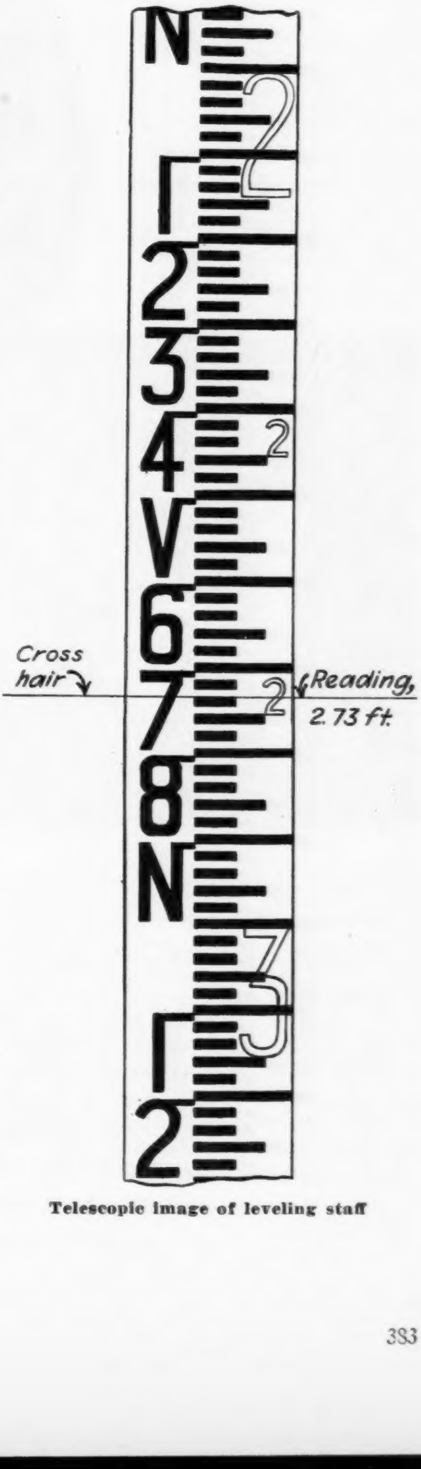
the plant and the gold recovered and weighed. To determine the gold content of the gravel to be used, a 3-yd. pile of gravel was sampled by putting every fifth shovelful in sample boxes until 25 cu.ft. had been so taken. The 25 ft. of gravel was then washed and the gold recovered. This operation was repeated and the average of the gold recovered in the two operations (253 milligrams, or 15.2c.) was taken as the gold content of the 25 ft. of test gravel.

Into 25 cu.ft. of this sampled gravel were mixed 30,553 milligrams of fine gold typical of the district and similar in character to that being recovered by the sampling operations. This salted gravel was then washed, and the gold cleaned up and weighed. The only departure from ordinary procedure was that the gold from different parts of the plant was cleaned up and weighed separately. Results of the test are given in the accompanying table.

Easy-Reading Leveling Staff

THE use of inverting telescopes in surveyors' instruments necessitates the operator acquiring a facility in reading inverted figures on a leveling staff. This habit is readily acquired, but the possibility of error is always present, writes Arnold B. Black, surveyor to Broken Hill South, Ltd., Broken Hill, Australia, who, with A. S. Lewis, has devised the easy-reading inverted staff graduation shown in the accompanying illustration. The idea of using inverted figures is not new, but this application of the principle is believed to be.

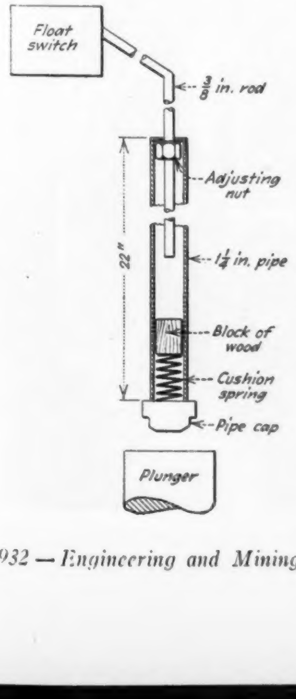
With the type of staff illustrated, the surveyor records, without a second look, what he sees in the telescope image. For instance, referring to the illustration, the line of sight cuts the figure 7 at the third 1/100-ft. interval, and the small figure 2 (which is in red) is seen at the side of the staff face. The staff reading is therefore 2.73 ft. The tag joining the top of the figure 7 to the 1/10th mark emphasizes 0.7 ft., and is an additional aid to speed and accuracy.



Telescopic image of leveling staff

Float Switch for Governor

AT THE Bingham Mines of U. S. Smelting, Refining & Mining Company, in Utah, the brake appliances on the hoist are controlled by oil pressure, which must always be kept constant. This is accomplished by means of an accumulator, consisting of a cylinder containing oil in which a plunger works up and down as the quantity of oil varies. Pressure is supplied by two small pumps driven by 1½-hp. motors, one being a standby. Formerly, one operated at all times, excess oil being bypassed around the reservoir. C. L. Moore, chief electrician, however, has designed a governor that permits the pressure unit to be driven only when the quantity of oil drops below a certain point. By use of this device, the running time of the accumulator is reduced 85 per cent, effecting a considerable power saving as well as diminishing the noise in the hoist room and reducing the wear and tear on the accumulator.



The device, shown in the accompanying sketch, consists of a 1¼-in. pipe, 22 in. long. The upper end is welded and drilled for a ⅜-in. rod, which is connected to a float switch. This rod, projecting into the bottom of the pipe, strikes a spring cushion to protect the switch contacts. This consists of a block of wood and a coil spring, resting on an ordinary pipe cap that closes the end of the pipe. Below is a plunger, which is forced upward by the pressure of oil from the driving unit. This strikes the pipe cap, and, as it goes up, actuates the rod upward, operating a float switch on the ceiling of the hoist room. This, in turn, controls the motors through a magnetic switch. As the plunger recedes, the pipe falls until a downward pressure is exerted on the adjusting nut, the weight of the pipe operating the float switch and starting the oil pump. Starting weights must be free, so that the accumulator can drop away after reaching starting position, thus utilizing all accumulator travel.

Underground Scraper and Conveyor Practice in South Africa

Scraper transport of ore at an East Rand gold mine. At the top is a native worker operating a jack-hammer in a 24-in. stope.

Loaded scraper approaching grizzly.

Power end of a scraper. The hoist is operated by compressed air.

From the grizzlies, the ore is moved on shaker conveyors to loading points along the underground haulage system.

Lubrication and Economics

E. R. Woodward

In two previous articles on this subject Mr. Woodward has dealt mainly with liquid lubricants. In this article, concluding the series, he discusses semi-solid lubricants and high-pressure lubricating systems

THE oil industry, generally speaking, makes more profit in selling grease than in selling oil. Purchasers of lubricants may do well to remember that grease is sold by the pound. The maximum of a series of grease prices that range from 3 to 12c., compared with 60c. per gallon for oil, looks like a bargain. When 12 is multiplied by 8, to express the price of grease on a gallon basis, then 96c. per gallon of grease compared with 60c. per gallon of oil puts a different aspect on the matter. A gallon of grease may go further than a gallon of oil, depending on circumstances and methods of application, but no positive statement can be made.

These remarks should not be considered as belittling the value of grease lubrication, or denying the need to use it; for in many mechanisms the use of oil as a lubricant is impracticable or extravagant. In some instances a lubricant is required that will be retained by an imperfect housing; in others, grease offers greater advantages from the standpoint of convenience in handling and ease of application.

In the manufacture of grease, an alkali, such as lime or caustic soda, is mixed with animal or vegetable oil. The chemical reaction between the alkali and the free fatty acid contained in the oil, known as saponification, is similar in principle to the reaction used in soap making. With the soap at correct temperature, petroleum oil is then stirred in. Characteristics of the resultant grease will depend on the quality and proportions of its constituents, and also on the care and skill used in putting them together. The main types are known as cooked greases and cold-set greases. The former comprise high-pressure, cup, fiber, and graphite greases; also gear compounds. In the latter category are included axle and other greases suitable for slow-moving bearings.

Inferior greases often contain animal fat that is or may become rancid. Such greases may give off offensive odors when kept in a hot engine room or store room, thereby prejudicing engineers against the use of grease. The scenting of inferior greases is practiced to mask such odors. When animal fat turns rancid, the chemical reaction is represented by an increase in free fatty acid content. This organic acidity, when too high, is likely to have a detrimental effect on bearings. For those prejudiced by this experience, the remedy lies in the use of better-quality grease. A slight increase in the price paid for lubricants has frequently been a factor in reducing shutdown time.

High-grade greases may contain horse fat, lard oil, tallow, or hog fat. Degras (wool-fat), whale oil, fish oil, and some of the vegetable oils such as palm, cottonseed, and soya-bean oil are used less frequently. Horse fat is found to make cup greases that are smooth and of uniform consistence.

The real lubricating value of a grease lies in the contained petroleum oil. For heavily loaded bearings, the more viscous the oil—within certain limits—the better the lubricant; also, more economy results by maintaining a low coefficient of friction under heavy pressure. Greases should be free from fillers, which are merely weight-making, non-lubricating materials sometimes added to inferior greases. Examples of such fillers are wax, resin, talc, mica, and other substances that are valueless from a lubrication standpoint. They may be harmful to bearings.

Lubrication of rubbing surfaces is accomplished best by a liquid film having the property of oiliness; the fact is not generally recognized that the same is true when grease is used as the lubricant. Contained mineral oil, and not the soap structure, furnishes the lubrication. The function of the soap in grease is analogous to that of a sponge—it permits the grease under slight pressure to force out the mineral-oil lubricant. Consistence in greases is controlled by the petroleum-oil content: the less the petroleum oil content the harder or thicker the grease, and vice versa. When kept for long periods at average warehouse temperatures, oil slowly separates from grease; and, for this reason, greases should be stored in light-iron drums, wood barrels being unsuitable because of the hazard of oil seepage.

Napoleon said that an army moves on its stomach. With equal truth one may say that industry moves on a film—a lubricating film of microscopic thickness, without which the moving parts of machinery would slow down and stop. Lubricating grease performs many functions in easing the way of industry, as surely as does lubricating oil. Cars that transport ore are exposed to dust and grit. Smooth-running journals are assured by correct selection and application of grease.

Petroleum-oil content of cup greases may be between 70 and 99 per cent. The importance of selecting correct grades of oil for various lubrication conditions has a close counterpart in the selection of lubricating greases. As an oil of specific viscosity is selected to suit a specific condition, so the viscosity of the petroleum oil in the grease should be suited to the conditions for which it is recommended.

Most cup greases are made up with a light lubricating oil of 90 to 110 sec. Saybolt viscosity at 100 deg. F.; better grades contain heavier oil, with a viscosity of 180 to 200, at 100 deg. F. High-pressure greases, which have now come so much to the fore with the adoption of high-pressure lubrication, are designed to resist the conditions that tend to force grease from the bearings. These greases usually contain oil of about 300 sec. Saybolt viscosity at 100 deg. F. Pressure grease has a longer life than ordinary cup grease. It is more easily applied by means of a high- or low-pressure gun, and is more color-stable, because of its greater resistance to oxidation under service and storage conditions.

Cup-Grease Specifications

Contained Petroleum Oil; Say. Vis. at 100° F.	Flow Point of Grease, Deg. F.	Consistence of Grease	A.S.T.M. Penetration
180-200	140-150	Soft	300
180-200	165-175	Medium	200
180-200	210-220	Heavy	125
250-300	140-150	Soft	300
250-300	165-175	Medium	200
250-300	210-220	Heavy	125
360-410	140-150	Soft	300
360-410	165-175	Medium	200
360-410	210-220	Heavy	125

In confirmation of what has been said regarding the close similarity in recommendations as between oil and grease for a specific lubrication purpose, G. B. Vroom (*Journal*, American Society of Naval Engineers, Vol. 37, No. 3, p. 553) considers that the petroleum oil in a cup grease should have the same characteristics as those of an oil specified for similar operating conditions where oil could be used. Specifications of a suggested series of cup greases, with this thought in mind, are given herewith.

Fiber greases do not contain textile fibers, as the name might imply. The fibrous nature of the grease is produced in the process of manufacture. The grease is heated to an extremely high temperature, with constant stirring; and, after reaching a certain stage in the process, the grease itself acquires a stringy or fibrous texture when pulled out. A grease of this kind will withstand more heat than other greases, and is therefore suitable for the lubrication of bearings operating at high temperatures. Fiber greases have a great tendency to cling to metal surfaces; they do not channel readily, and are therefore suitable for gear lubrication.

Wool-yarn greases furnish the modern substitute for the old method of using wool waste and black oil for the lubrication of underfed bearings: the mixture of wool and hair keeps the lubricant constantly in contact with the revolving journal. Wool-yarn grease is particulary suitable for the lubrication of electric-motor bearings.

Mine-car greases are made in two or three grades: (1) A semi-plastic lubricant applied with a grease gun; it remains plastic at low temperatures and is well adapted for use in all types of mine-car journals, including those equipped with roller bearings; (2) a grease of similar quality but of softer consistency; (3) a black grease of lower price.

In industry generally a significant factor in lubrication economics is the trend toward the development and adoption of central and high-pressure lubrication systems. One machine has over 500 lubrication points, each of which must be fed with minute quantities of oil every few minutes. A carefully designed system using gravity oilers and compressed air is controlled by an electric timing device. Adjustment permits a rate of feed from one drop to forty drops in twelve minutes. The reduction in time and labor involved is apparent.

High-pressure grease lubrication systems have also been developed to insure positive lubrication of mining machinery in place of the old hit-and-miss methods of grease cups and oil holes. Outstanding features of high-pressure lubrication are: (1) The use of a lubricant that "stays on the job," clinging to the bearing surfaces until its work is done; (2) application under pressure of 2,000 to 5,000 lb. per square inch forces the lubricant to all parts of the bearings; (3) introduction of fresh lubricant under such pressure automatically pushes out spent grease, grit, and other foreign matter, which, by its continued presence, would in time cause excessive bearing wear and deterioration.

The advantages in an installation of a system of this type are readily seen when one contrasts it with the old-fashioned grease cups, the best of which developed a pressure of not more than 40 lb. per square inch. Furthermore, the wastage and inefficiency of hand oiling has been shown by a close study, which revealed that only 2 to 4 per cent of the oil squirted into a bearing provides actual lubrication. The remaining 96 to 98 per cent drips onto the floor, causing damage and unsightliness. Some users of high-pressure lubrication systems claim to have shown actual savings of 200 per cent on investment in equipment and lubricants.

Another important consideration is the increased safety of workmen. Many accidents occur to men while they are near moving machinery and trying to reach lubrication points. This hazard can be avoided by the use of header blocks containing several nipples or push-type fittings, together with their tube couplings. Lubricant is carried from the header blocks to the bearings through $\frac{1}{8}$-in. copper tubing. In industrial lubrication today the trend is toward the centrally located power unit, with convenient outlets near plant machinery.

Where lubrication records and cost studies show definite economies, equipment of this type should be purchased without delay. A good time to do this is when mines and plants are working on reduced production schedules. If funds for this initial outlay are not available, a member of the engineering department who has charge of lubrication supervision should have data on hand—records, quotations, installation plans—in preparation for the time when improved business conditions warrant the necessary expenditure.

Manufacturers of mining equipment have the following to say about the lubrication systems in connection with their machinery:

A manufacturer of diamond core drills fits all his machines with a high-pressure system, and believes that this method of lubrication is most suitable for surface or underground work.

A manufacturer of magnetic separators explains that, because the speeds are low, he generally uses grease-cup lubrication; but, for some large machines shipped recently, he installed a high-pressure lubrication system that is working well.

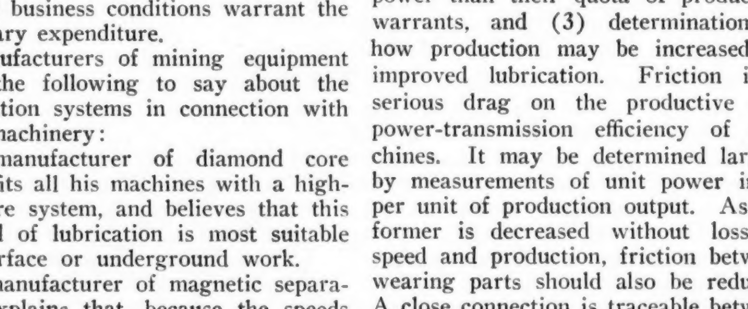
A leading mine-car manufacturer offers a variety of lubrication methods. On his equipment he sometimes uses high-pressure fittings in the hubs of the wheels or in the journal boxes. In other cases he equips cars with the standard-roller bronze-bearing journal box, which is waste-packed. He also builds cars that are merely provided with oil holes tapped to receive pipe lugs. The inefficiency of this method has already been emphasized.

A manufacturer of rib-cone ball mills points out that his mills are mounted on support wheels fitted with oversize bearings. The bearings are completely inclosed in dust-proof and water-tight housings, with large spaces to retain grease. Special attention has been paid to the grease inclosures so that none can escape.

A manufacturer of single- and double-deck vibrating screens states that when the screens are operating under fairly clean conditions a heavy steam-cylinder oil is satisfactory. Vibrators usually work under wet or dusty conditions. The bearings are protected with piston-ring seals. Grease lubrication is preferable to oil lubrication under these conditions, on account of the greater exclusion of dirt and grit. Care must be taken to avoid the use of greases containing non-lubricating fillers, as these may cause the rollers to jam, in which event the bearings must be taken apart and cleaned.

A study of lubrication and economics involves knowledge of (1) the operating efficiency of equipment; (2) discovery of individual machines taking more power than their quota of production warrants, and (3) determination of how production may be increased by improved lubrication. Friction is a serious drag on the productive and power-transmission efficiency of machines. It may be determined largely by measurements of unit power input per unit of production output. As the former is decreased without loss of speed and production, friction between wearing parts should also be reduced. A close connection is traceable between cost of lubrication and cost of power in the operation of mine, mill, and power house.

A judicious use of the principle of economics applied to lubrication can therefore prove of cash value in avoiding loss and increasing productive efficiency by correlating these benefits by definite planning based on facts. "Life is an arch where through gleams the untraveled world." As we emerge from the arch of depression let us apply the lessons learned in the hard school of economic necessity.



Employee Housing—III

A. H. Hubbell
Associate Editor

A LITTLE over fifteen years ago, the Burro Mountain Copper Company, of the Phelps Dodge Corporation, erected some very attractive houses, in varied designs, at its mining camp of Tyrone, N. M., now temporarily

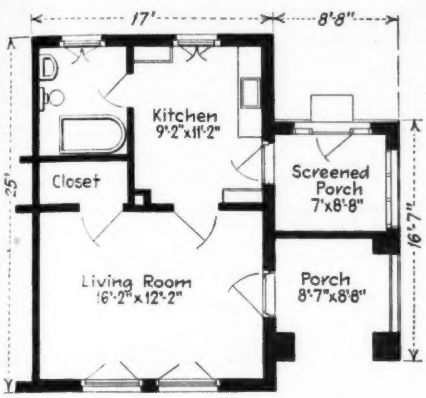


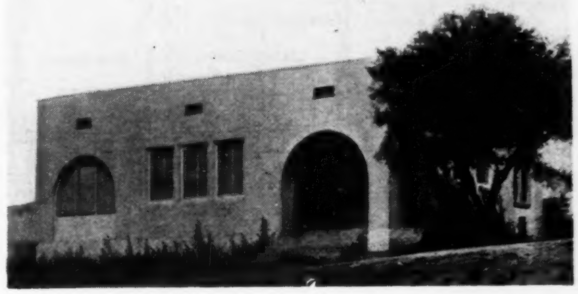
Fig. 17—Half of double house having two two-room apartments, American employees, Tyrone, New Mexico

shut down. Accommodations were provided for both American and Mexican employees. Some of these houses are shown in Figs. 17 to 23 inclusive. Those pictured in Figs. 17, 18, 19, and 20 are also shown in accompanying photographic illustrations. All of these buildings were designed by the late Bertrand G. Goodhue, a New York architect.

Double house for American employees. Plan shown in Fig. 17.

Permission from Mayers, Murray & Phillip, his successors, to reproduce the drawings and photographs here presented has been obtained through the courtesy of Mr. Cleveland E. Dodge.

In previous installments has been described employee housing at Luanshya, Northern Rhodesia; Newgulf, Gulf Coast, Texas; Matahambre, Pinar del Rio, Cuba; Achotla, Guerrero, and Monterrey, Nuevo Leon, both in Mexico; and the Upper Pecos Valley, New Mexico.



Four-room single-family house for American employees. Plan shown in Fig. 19.

Average temperature in summer in Tyrone is 72 deg. F. and in winter 38 deg. F. Annual precipitation is approximately 15 in., 85 per cent being rain and the rest snow.

The houses shown in Fig. 17 to 20 inclusive are allotted, when the camp is active, to American employees, such as shift bosses, foremen, engineers, and others of similar classification. Briefly described they have concrete foundations, 8-in. hollow-tile walls, inner walls of metal lath and plaster on wood studding, and a colored stucco exterior. They have small cellars, and the front and rear porches are screened. As the

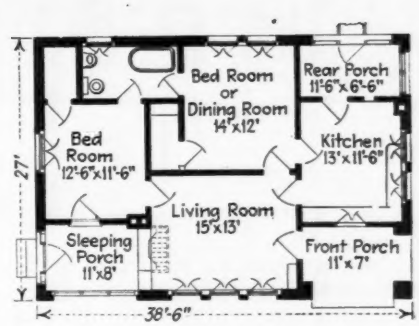


Fig. 19—Four-room single-family house, American employees, Tyrone, New Mexico

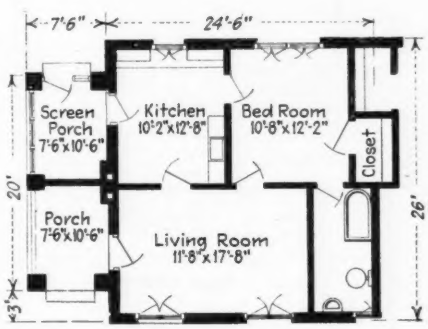


Fig. 18—Half of double house for American employees. Similar to that in Fig. 17, but having two three-room apartments

illustrations show, they have flat roofs, covered with J-M three-ply asbestos roofing. They are completely equipped with modern plumbing in bathroom and kitchen and are wired for electricity, with modern fixtures, as well as with floor and wall outlets for lamps and electrical appliances.

The camp is supplied with water pumped from deep wells to a 100,000-gal. storage tank, from which it is distributed to the houses through standard mains. All houses are likewise connected to a modern sewage disposal plant. Stoves are provided for heating and cooking. Owing to the temperate

Double house for American employees. Plan shown in Fig. 18.

climate, no special materials were used for insulating against loss of heat.

Cost of these houses varied considerably. Those shown in Figs. 17 and 18 are double houses and cost, respectively, $1,340 and $1,825 per apartment, in 1915. The house shown in Fig. 19 cost

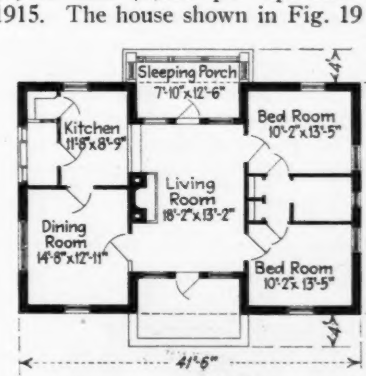


Fig. 20 — Five-room one-family house allotted to American employees, Tyrone, New Mexico

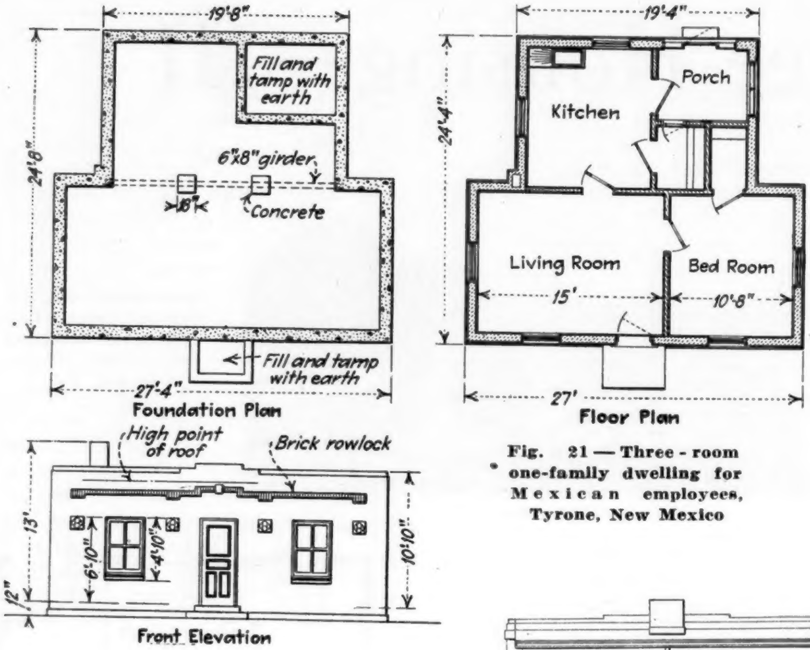


Fig. 21 — Three-room one-family dwelling for Mexican employees, Tyrone, New Mexico

The cost of this house in 1915 was $1,370. In addition to the rooms there is a so-called kitchen service porch, as shown. Save for the fact that this house has cement floors, its construction is the same as that of the one shown in Fig. 21. Attention is called to Section C-D, Fig. 22, demonstrating the construction of the wall. Somewhat similar is the dwelling shown in Fig. 23. This is a double house, each apartment having three rooms and a porch. This house also has cement floors, being otherwise the same as Fig. 21.

Housing of the United Verde Copper Company at Clarkdale, Ariz. At Clarkdale, in the Jerome district of Arizona, the climatic conditions are mild, the average summer temperature is 75½ deg. F., and that of the winter 49 deg. F.

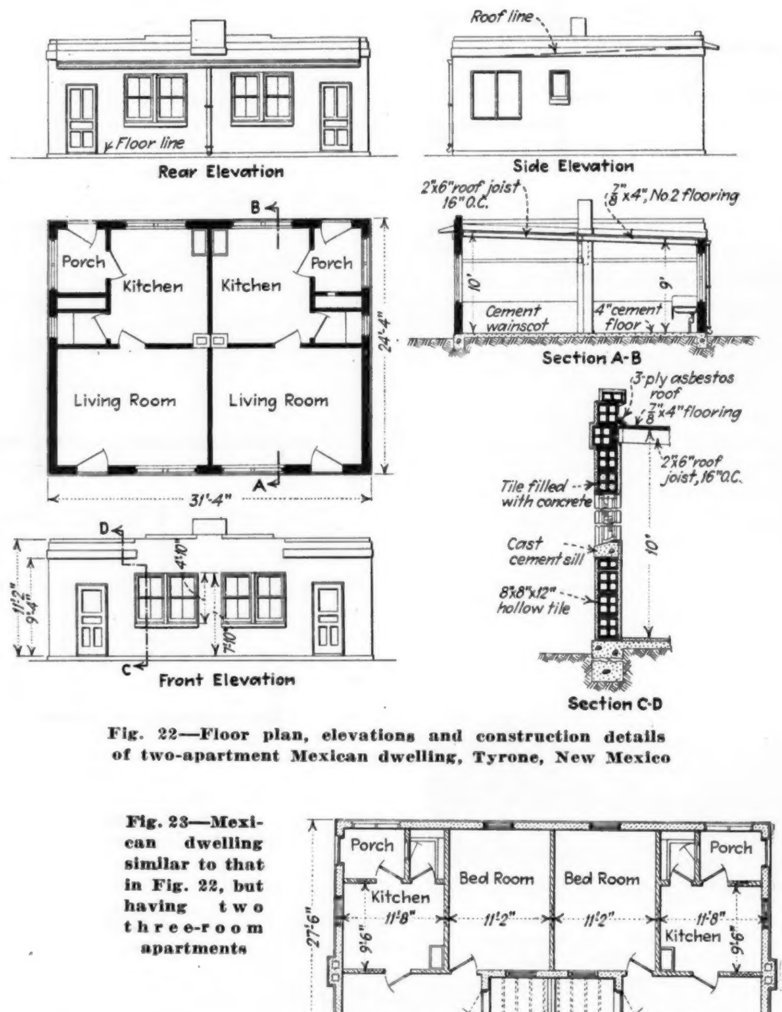


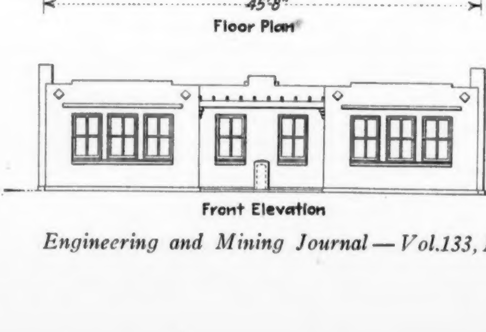
Fig. 22—Floor plan, elevations and construction details of two-apartment Mexican dwelling, Tyrone, New Mexico

$2,550 in 1915, and that shown in Fig. 20 cost $3,400 in 1916.

Mexican employees are housed in the dwellings shown in Figs. 21, 22, and 23. Fig. 21 shows a three-room dwelling that cost $1,140 in 1915. It is intended for occupancy by a single family. Construction features include hollow-tile walls, a pebble dash cement stucco exterior, and wood floors. The roof is flat and is covered with three-ply asbestos roofing. The roof timbers are 2x6-in. joists spaced on 16-in. centers. No air space is required below the roof for insulation against heat. Interior partitions are of cement stucco on metal lath with wood studding. Both front and rear porches are of cement. Window sills are of cast cement, as is the sill of the front entrance. For decorative purposes, a brick rowlock and four brick panels are built into the facade, as indicated in the elevation in Fig. 21. Doors are 2 ft. 8 in. by 6 ft. 8 in. by 1⅜ in.; windows are 2 ft. 9 in. by 12 ft. 6 in., 1⅜ in., each having four lights, 14x24 in. in dimensions. The inside sink and outside toilet are connected to the main sewage disposal plant. Electricity is used for heating in all these houses. Likewise, stoves are used for heating and cooking, wood and coal both being available.

Fig. 22 shows a Mexican dwelling containing two two-room apartments.

Fig. 23—Mexican dwelling similar to that in Fig. 22, but having two three-room apartments



Five-room one-family house for American employees. Plan shown in Fig. 20.

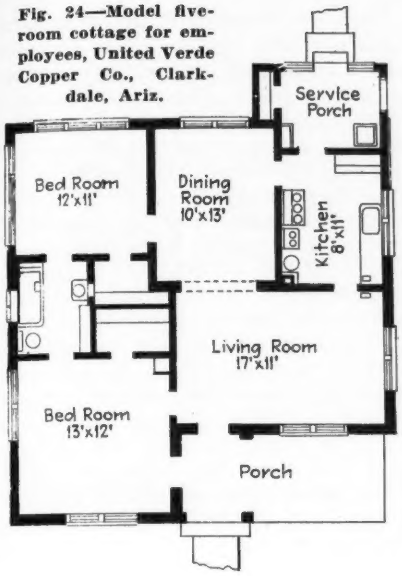


Fig. 24—Model five-room cottage for employees, United Verde Copper Co., Clarkdale, Ariz.

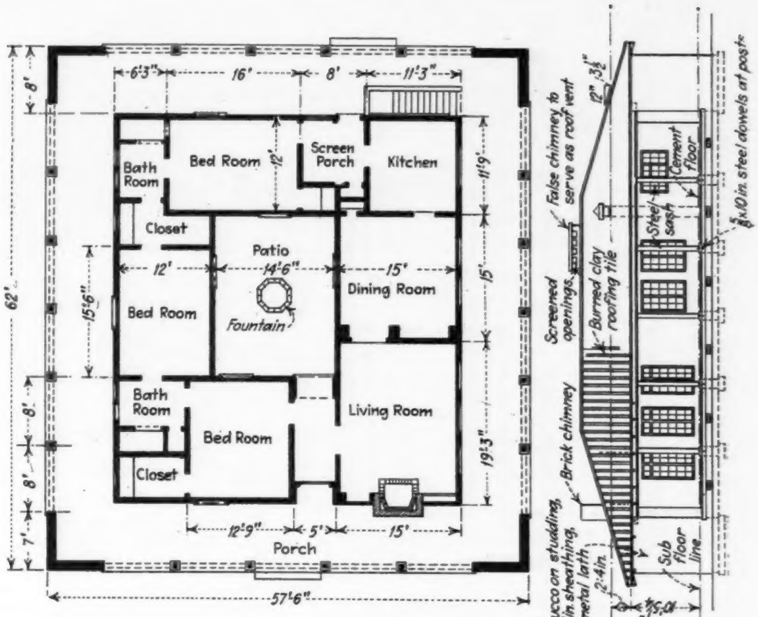


Fig. 25—This dwelling is the most expensive of the one-family houses provided for its staff by American Potash & Chemical Corporation, Trona, Calif.

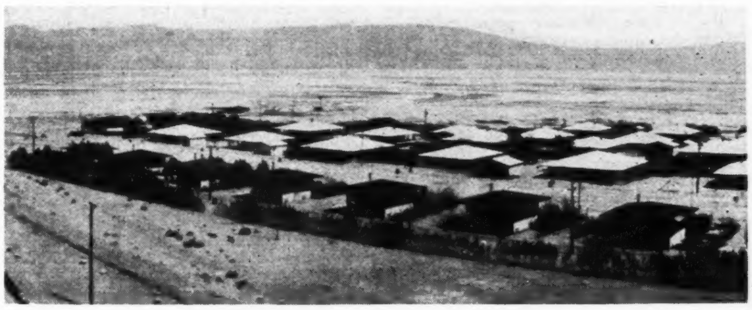
The average yearly precipitation is 13.07 inches, all of which is rain.

For its married American employees, the United Verde company has provided substantial dwellings, either of brick or hollow concrete tile. These have concrete foundations and a composition or wood shingle roof. Inside walls, or partitions, are plastered on both sides. The number of rooms varies. The dwellings include two-, three-, and four-room houses, which are provided with toilet and shower bath; three-, four-, and five-room houses, in which a tub is substituted for the shower; and three-, four-, and five-room houses of hollow concrete tile construction, which are equipped with toilet and tub bath. These dwellings are occupied by American employees, including technicians, foremen, mechanics, smelter men, laborers, and others of similar classification. Hot and cold running water is provided in kitchen and bath, and a hydrant in the yard. The dwellings are wired for electric light and electric cooking. No provisions are made for heating, the tenant furnishing the stoves.

For its married Mexican employees the company provides two- and three-room patios equipped with shower bath and toilet. For unmarried men, the company has two hotels or dormitories of brick construction.

Cost of the dwellings described ranges from $1,200 to $5,000 each. Rentals vary from $10 to $40 per month. Most of the houses have either three or four rooms and rent for approximately $21 per month. In the dormitories, or hotels, the rooms are rented for $10 to $15 per month per man. The charge for the $15 room includes a shower bath with hot and cold water in the room. The $10 room, however, has a shower bath only. Fig. 24 shows a five-room cottage recently built in Clarkdale, which is said to be satisfactory and to rent for $27.50 per month.

In the houses described no special materials for insulation against loss of



Part of the residential district of Trona

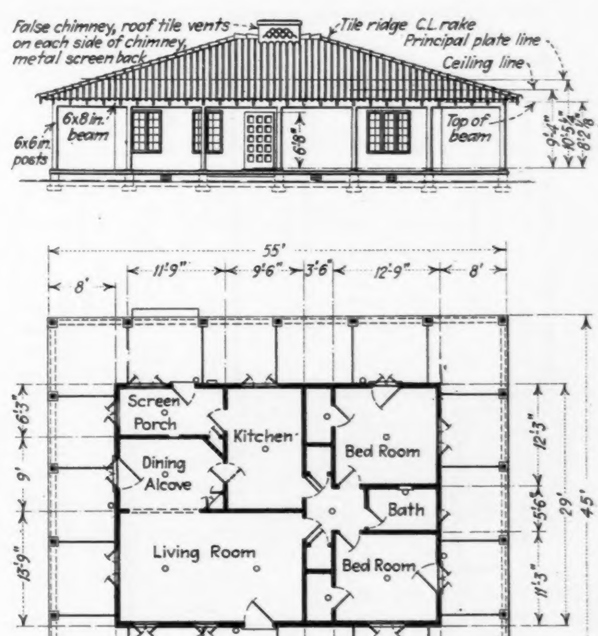
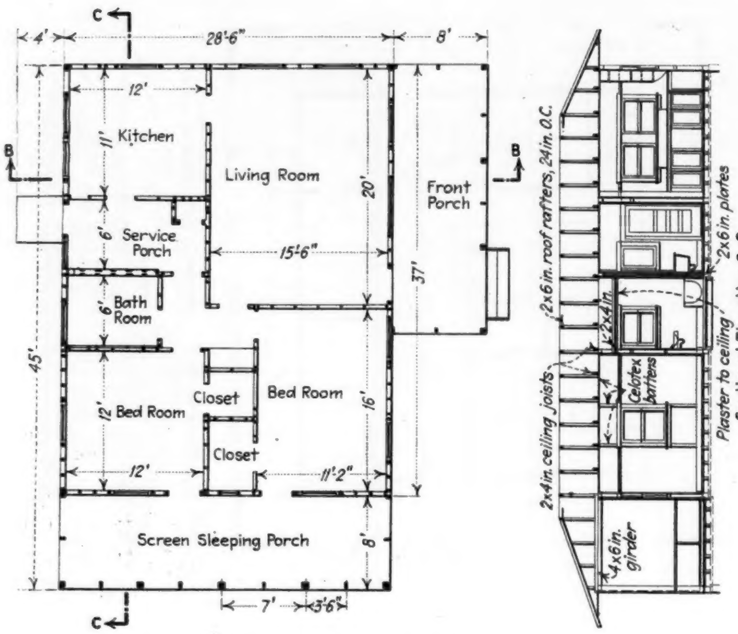


Fig. 26—Six dwellings of this type are among those provided at Trona for the staff



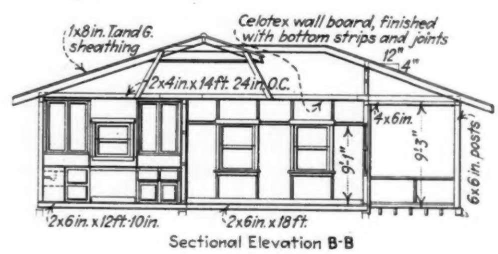


Fig. 27 — Twelve one-family dwellings such as this, together with those shown in Figs. 25 and 26, constitute the housing provided at Trona for families of married executives

heat are used, the mild climatic conditions making ordinary good construction sufficient.

Housing of the American Potash & Chemical Corporation, Trona, Calif. At Trona, in the Mojave Desert, the American Potash & Chemical Corporation normally employs about 650 men. To accommodate them it has provided a large number of attractive houses of varied designs, built especially to afford comfort in the climatic conditions that prevail. During nine months of the year these conditions are pleasant. June, July, and August, however, are usually warm, the maximum temperatures ranging from 100 to 115 deg. F., and the minimum from 65 to 85 deg. Although the summer days are hot, the low humidity of 12 per cent, with the resulting high evaporation rate, is said to make even the hottest days bearable. Nights are comfortable, owing to the elevation and the rapid radiation. In January and February the maximum ranges from 60 to 75 deg. F., and the minimum from 25 to 55. Average annual rainfall is only 3½ in.

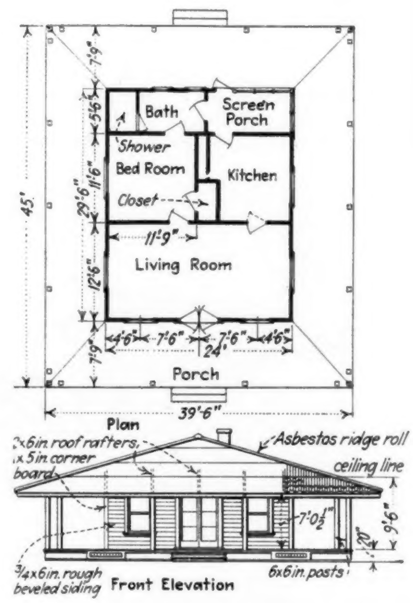


Fig. 29—This dwelling is of the same class as the one shown in Fig. 28

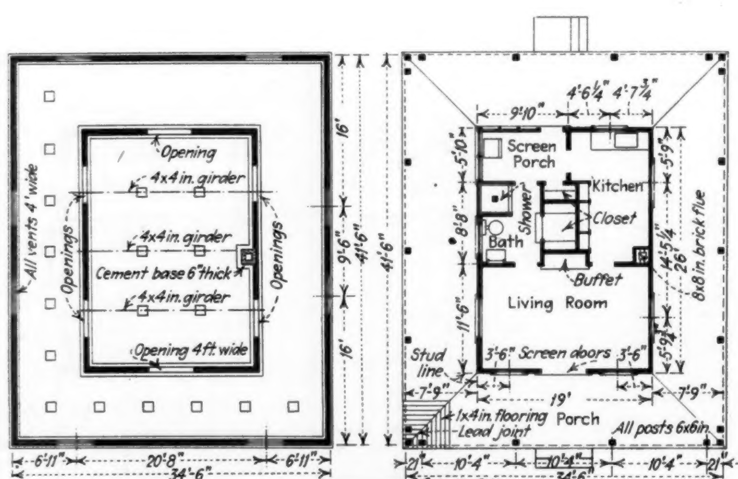


Fig. 28—In general design and varying only in room layout, this type of dwelling, together with the types shown in Figs. 29 and 30, is typical of the 87 miscellaneous houses furnished at Trona for technical men, foremen, and other married employees

For its executive staff, the company has provided nineteen houses, including one of the type shown in Fig. 25, six of the type illustrated in Fig. 26, and twelve others typified by Fig. 27. Unmarried executives live and eat at a clubhouse managed by the company, which is not considered in this article. Technical men, foremen, and other employees filling the more important positions are housed, if married, in 87 miscellaneous dwellings, of which Figs. 28, 29, and 30 may be regarded as representative.

The majority of the employees are housed in bachelor quarters, or bunk houses, such as shown in Fig. 31. These buildings have either one or two stories, each story having twenty living rooms for two men each, in addition to a

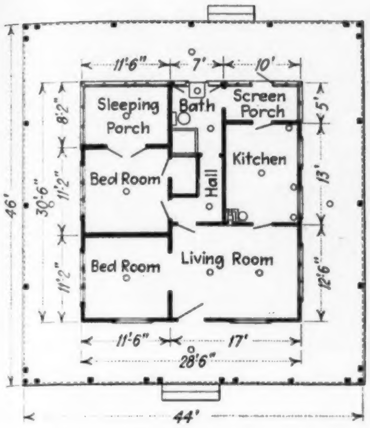
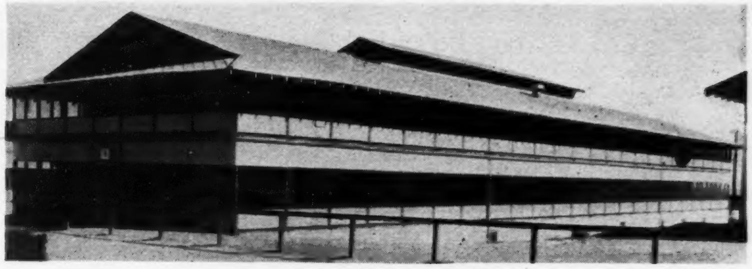


Fig. 30—The design of this house differs only in room layout from those illustrated in Figs. 28 and 29



One of the two-story bunk houses provided for single employees by American Potash & Chemical Corporation. See Fig. 31.

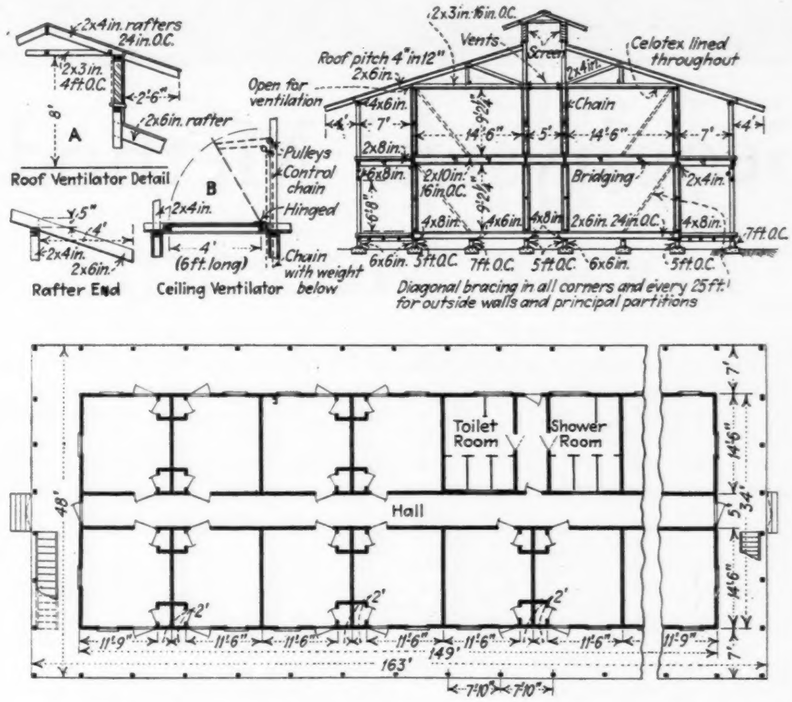


Fig. 31—Layout of first floor of two-story bunk houses; also a cross-section showing framing details. The second floor, if any, is essentially the same.

shower room and a separate toilet room. Thus, each bunk house will house either 40 or 80 men. No negroes or Orientals are employed. A few Mexicans are housed in a separate section of the village. Tents have been used at times for housing men temporarily employed on construction work.

The cost of the family residences, illustrated in Figs. 25 to 30, inclusive, ranges from $3,000 to $7,000 each. The bunk houses, shown in Fig. 31 and in one of the photographic reproductions, range in cost from $20,000 to $35,000, depending on whether they are one or two stories in height.

Electricity is generated by the company and sold to employees in residences at a very low rate. Quarters for single men (and single women) are uniformly equipped with electric lights, steam heat, hot and cold running water, showers, and modern toilet facilities. They are said to be well furnished, bed linen and blankets being provided and the rooms being cleaned and beds made daily by company attendants.

The camp is served by two water systems, one supplied from mountain springs and serving domestic requirements. The other system is supplied from wells in the valley, the water being slightly saline and used for the industrial requirements. Bathing for recreation purposes is permitted in a regulating reservoir, which is a part of this system.

The dwellings shown in Figs. 25 and 26 are of standard wood-frame construction and have concrete foundations and basements. The exterior is of stucco on metal lath laid on 1-in. sheathing which is nailed directly to the studding. The interior is of plaster on metal lath. Steel sash, tile roofs, cement porches, hardwood floors, and steam heat are among the other features. The dwelling shown in Fig. 25 has a central patio approximately 14 ft. 6 in. by 19 ft. 3 in. in dimensions. These houses are provided with false chimneys, shown in the elevations, which serve as roof vents. Vents of hollow tile are also provided in the foundations.

In the dwellings typified by Fig. 27, all lumber used for framing is No. 1 common Douglas fir. All sills are redwood, and floors are of maple or Oregon pine. Roof rafters are 2x6 in., spaced on 24-in. centers, and overlaid by 8 in. tongue-and-grooved sheathing. Ceiling joists are 2x4 in., spaced on 24 in. centers. Floor joists are laid on 16-in. centers. The studding is 2x4 in. spaced on 16- or 24-in. centers, according to position. Exterior walls are covered with Celotex sheathing, metal lath and stucco. On the inside, all walls and ceilings are covered with 7/16-in. Celotex wall board.

The houses shown in Figs. 28, 29, and 30, representative of the 87 mentioned, are of standard wood-frame construction, with wood lath and plaster on the inside, rustic siding, and corrugated asbestos roofs. They are heated by wood stoves. Details of the foundations are shown in Fig. 28. Other principal details of construction are shown in the drawings.

Details of construction of the bunk houses are sufficiently shown in Fig. 31. These buildings are of standard wood-frame construction, with the interior of Celotex wallboard and the exterior of rustic siding, and the roof of asbestos shingles. Like the other buildings, they are steam heated. Porches are screened all around. Among the more interesting

One-family dwelling at Trona, typical of half of the company's houses

details is that of the roof ventilator, which is shown at "A," and the ceiling ventilator, shown at "B." The hinged door of the latter is controlled by means of a chain and weight.

(To be continued)

Geophysical Methods Locate Meteorite

J. J. Jakosky

FOR more than twenty years, search has been directed toward location of the meteorite that fell at Meteor Crator, near Winslow, Ariz. Reliable estimates place the cost of this search at more than $500,000. Recently, Meteor Crater Mining & Exploration Company, the present operators, drilled for the meteor at locations recommended as a result of geophysical and geological studies conducted during the summer of 1930. These drilling operations have proved the correctness of the geophysical results, as regards occurrence of meteoric material and structural conditions.

The geophysical examination, conducted by International Geophysics, of Los Angeles, Calif., consisted of complete geological, magnetic, and electrical surveys, together with associated laboratory studies conducted at the geophysical company's research laboratory in Culver City. Field and laboratory work was carried out by myself, C. H. Wilson, and J. W. Daly, technical director, mining engineer, and geologist, respectively, of that company. The final results obtained and recommendations made were the result of close correlation of the independent results of the three separate surveys and the results of geological, magnetic, and electrical measurements and studies made in the laboratory.

A detailed discussion of the work is contained in a paper presented at the New York meeting of the American Institute of Mining and Metallurgical Engineers, February, 1931.

Mining exploratory operations have been conducted intermittently during the past twenty years at Meteor Crater, by various groups who believed that the crater was of meteoric origin, and who hoped that sufficient quantities of meteoric material lay buried to prove commercially valuable as a mining project. The presumption of value was based upon an expected large tonnage, and the fact that the many meteoric fragments found on the surface gave average analyses of about 8 per cent nickel and important percentages of platinum.

In the early work, numerous drill holes and shallow shafts were put down, mainly in the northern portion of the crater. Considerable difficulty was encountered in trying to penetrate through the débris in the crater. To overcome this difficulty, the present management started a 1,500-ft., two-compartment shaft, on the south rim of the crater and outside the zone containing débris. The intention was to sink this shaft in the solid rock outside of the crater and then to crosscut, at a depth of 1,500 ft., to the presumed location of the meteorite. However, after the shaft was well under way, the enormous force responsible for the crater was found to have broken and shattered, in a radial fashion, the sedimentary rocks of the area for considerable distances from the crater. This difficulty in itself could have been overcome had it not been for enormous and unforeseen quantities of water that poured into the shaft through large cracks and fissures in the porous Coconino sandstone, at a depth of 650 ft. The impossibility of dealing with the large amount of water caused abandonment of the project. Meteor Crater Exploration & Mining then employed International Geophysics to obtain information as to the origin of the crater, and to determine the advisability of continuing exploration, and, in particular, where such exploration should be directed.

Meteor Crater, which lies in the high plateau of northern Arizona, about 20 miles southwest of Winslow, is a bowl-shaped, almost circular depression about 4,500 ft. in diameter and 600 ft. deep. The depression is surrounded by the crater rim that stands about 160 ft. above the general level of the plateau. As a natural wonder, Meteor Crater has long been a mecca for tourists and is visited annually by thousands of people.

The origin of the crater, of considerable scientific importance, has for many years been the subject of discussion by eminent astronomers and other investigators. Two of the many theories advanced have been regarded as the most probable explanation of the origin of the crater. The first of these, now proved correct, held that the crater was formed by a meteorite, or swarm of meteoric material, striking the earth at high velocity, and burying itself. The other prominent theory held that the crater was a result of a "steam" explosion, attributed to the accumulation of hot solutions or gases beneath the sedimentary beds overlying the area.

The geologic formations affected in the cataclysmic formation of Meteor Crater are those that comprise the plateau of northern Arizona. Kaibab limestone and Coconino sandstone of Carboniferous age, and Moencopic sandstone of the Triassic age, are exposed in the crater walls, and dip radially away from the center. The underlying Supai formation is not exposed, but it is known to have been affected in the cataclysm. The rim of the crater is covered with ejected débris, composed of an intimate mixture of fragments of the old sedimentary rocks, Le Chatelierite, rock flour, and meteoric material. The original excavation has been filled for about 700 ft. with this débris, which fell back after it was ejected. About 120 ft. of lake beds have been deposited above the débris that filled the crater. These are fine sands, marls, clays, conglomerates, and numerous beds carrying recent fossils.

Regionally, the structure consists of a thick series of concordant strata having a dip of a few feet per mile in a northwest direction. This series is broken at Sunshine Mountain, 12 miles southeast, at Black Mesa, 20 miles southwest, and at San Francisco Mountain, 45 miles to the northwest, by the feeder vents of the extrusive igneous rocks which occur at these places.

Locally, the structure is somewhat more complicated. Here, the rocks which lie nearly horizontal on the plateau are uptilted along the margin of the crater. The angles vary from 11 to 80 deg., but average about 30 deg. and dip away from the center of the crater. Numerous faults can be seen in the face of the crater walls, but cannot be traced beneath the débris inside or outside of the crater proper.

The field work was conducted by International Geophysics' usual procedure of applying various independent studies to an area, based on preliminary inspection, and consideration of factors governing the applicability of various geophysical methods. Each study was in charge of an independent worker or group.

For the electrical work, specially designed apparatus, developed by the research staff, and built in the company's laboratories, was employed. For the magnetic investigations, Askania magnetometers of the Schmidt vertical-type field balance were used. In connection with the magnetic work, calibration of instruments and magnets was conducted at the magnetic station of the U. S. Coast and Geodetic Survey Station at Tucson, Ariz. This work was done through the courtesy and cooperation of Dr. Albert K. Ludy, in charge of the Tucson station.

Briefly, the reports gave the survey results as follows:

1. Geological examination showed that the crater was meteoric in character rather than due to a steam explosion, as held by numerous investigators. It disclosed evidence that the meteorite still existed at depth in the southwestern part of the crater. Geologic evidence placed the age of the crater to be measurable in terms of thousands of years, probably about 50,000.

2. The electrical survey located the meteorite in the southwestern part of the crater, and indicated it to consist of a shallow fragmentized zone, surrounding a more concentrated main mass occurring at an effective depth of 700 ft. below the present crater floor. In addition, the depth to water and various geological horizons was worked out by the electrical survey. The depth to the water table was found to be 650 ft. in the region outside of the crater, and 230 ft. below the crater floor.

3. The magnetic survey revealed a magnetic high, due to the meteorite in the same area as indicated by the electrical survey, and revealed the presence of a shallow shattered area containing meteoric material above the deeper and more concentrated zone, indicated by the electrical survey.

From the results recorded in the foregoing, drill-hole exploration was recommended in five locations, placed so as effectively to determine the commercial value of the deposit. Two of these holes have been completed, both of them definitely checking the indications of the geophysical survey as regards the occurrence, location, and depth of the meteoric material, as well as the depth to water and other structural effects.

The following information on the results of the drill holes was obtained from G. M. Colvocoresses, general manager of Meteor Crater Exploration & Mining:

"The first hole, placed in the center of the favorable area indicated by the geophysical survey, ran into the zone containing meteoric fragments at a depth of 414 ft. Below this depth, for a distance of 261 ft., the drill hit meteoric fragments at frequent intervals, until at 675 ft. further progress was halted as the drill became lodged in the upper part of the more concentrated meteoric zone. It was necessary to employ special alloy bits in the rotary tools, because of the extreme hardness of the meteoric fragments, which resulted in nicking and denting and very rapid wear of the bit. The existence of the meteoric material was further proved by analyses of all sludge samples, which below a depth of 414 ft. showed the presence of nickel, this metal not being known to exist anywhere in this part of Arizona except alloyed with the iron in the Barringer Meteorite.

"The second drill hole, as far as it has been carried out, revealed similar conditions as the first. The fragmental zone was first penetrated at 500 ft.; and from this depth to a depth of 650 ft., the present bottom of the hole, meteoric fragments were encountered at frequent intervals.

"The drilling operations also showed close agreement between the actual depth to water and that predicted by the geophysical survey."

These results are evidence of the reliability of modern methods of geophysical prospecting. In the field of ordinary mining exploration the problems to be solved by application of geophysical methods rarely present such difficulties, in adapting a proper field procedure, and in interpretation of results, as did this Crater problem. When a geophysical survey is carried out with the use of proper technique, an up-to-date field procedure, and modern instruments, the economic benefits to be derived, in a program of mining exploration, are many. Such geophysical studies will secure subsurface geologic data that can be obtained in no other way, except at prohibitive cost.

■ ■ ■

Novel Connection for Butters Filters

FILTERING OPERATIONS have been considerably improved on the Witwatersrand by the adoption of the patented, self-adjusting connection shown herewith, the details of which were supplied by J. C. Phillips, Government Gold Mining Areas, Transvaal, South Africa. The connection constitutes the link between the filter leaf proper and the manifold connected to the suction line of the vaccum pump. This joint, unlike a connection of the bridle and thumbscrew type, requires no special packing. The extension on the sight glass fitting, provided with a short lug, is fitted with a tapered end, which, when inserted into the conical bore or valve seat of the spud, effects a water-tight joint after the revolving lock ring of the spud, containing a helical groove to accommodate the protruding lug of the sight glass fitting, has been turned. When disconnecting the sight glass fitting, to enable the operator to remove the filter leaf, the open spud end is rendered air-tight by inserting the small blank end piece illustrated. The connection is manufactured by the West Rand Engineering Works, Krugersdorp, South Africa.

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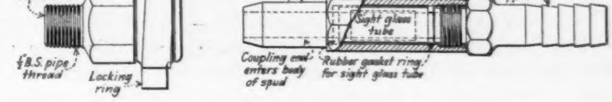


Sweden's New Gold-Copper Enterprise

E. Wesslau

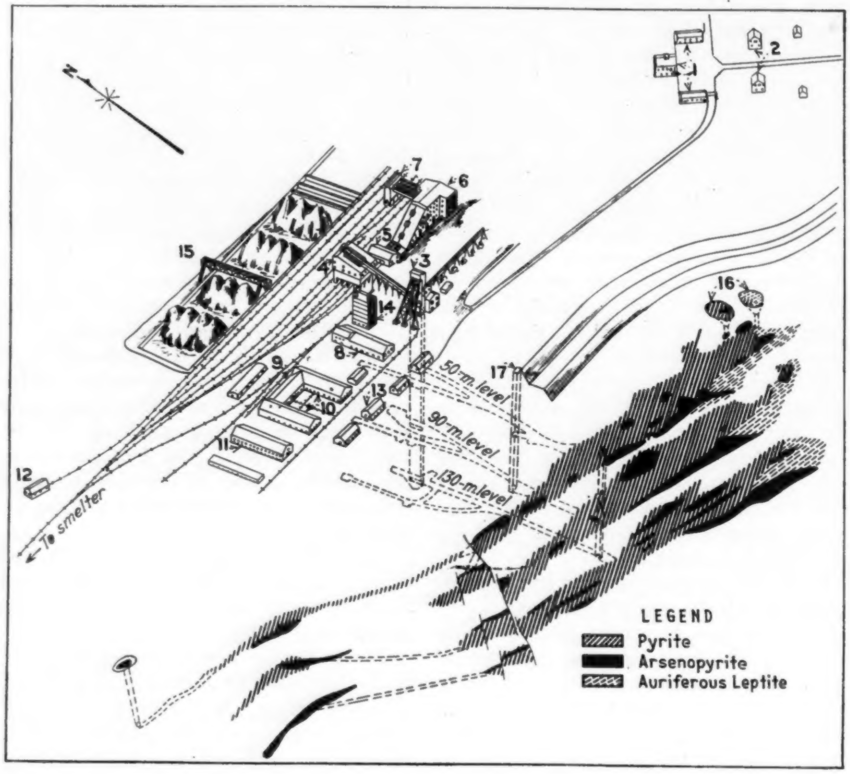


Fig. 1 — Isometric projection, showing surface layout, underground workings and orebodies

1. Office buildings
2. Foremen's houses
3. Central shaft and primary crushers
4. Sorting plant
5. Secondary crushers
6. Ore sampling and flotation testing plant
7. Fine-ore bin
8. Hoist and compressor house
9. Storehouse
10. Drill-sharpening and machine shop
11. Change house
12. Locomotive shed
13. Assaying laboratory
14. Central heating plant
15. Traveling crane
16. Open pits
17. Old shaft
18. Underground shaft

Photos Courtesy of American-Swedish News Exchange

BOLIDEN'S GRUVAKTIEBOLAG, the Boliden Mining Company, was organized to take over on Jan. 1, 1931, the mining properties and prospecting work of the Skellefteaa and Västerbotten Mining companies, the successors of the Centralgruppens Emissions A/B, which started prospecting work in the Skellefteaa district of northern Sweden in 1918.

The rocks of the Skellefteaa district are Archean. The oldest formation consists of a series of weakly metamorphosed lavas, mainly quartz porphyries and porphyrites with their tuffs and agglomerates. To a small extent volcanic greenstones—amphibolites—occur. This series, called the Leptite series, corresponds to the mineralized rocks of the mining district of central Sweden and the Keewatin of North America.

The Leptite series is conformably overlain by the Slate series, which consist of shales, slates, and schists, often carrying graphite and pyrites. Both series are intruded by the Jörn granite, an Archean rock that has caused intense metamorphism of certain zones of the Leptite series. Deposition of sulphides has taken place here.

Younger than these rocks is the Conglomerate series—Vargfors formation—consisting of conglomerates, sandstone, and greywacke. This formation probably corresponds to the Temiskaming in America. Large areas are composed of Refsund granite; the relation of this granite to the Vargfors formation is uncertain, but it is probably older. Both are associated with norites and gabbros. Small deposits of little economic importance, chiefly pyrrhotite, are found in the Slate series; but the main orebodies occur in the Leptite series, generally near or at the contact of the slates and leptites. They are usually lenticular, and show well-defined contacts with the country rock. Iron ores do not occur.

The district is overlaid with heavy glacial deposits and swamps. In areas covered by the Baltic Sea at the end of the glacial period, sand, silt, and clays are found. As the inland ice cap generally moved from northwest to southeast, the origin of ore boulders found in glacial deposits must be traced back in a northwesterly direction.

As outcrops are scarce, a detailed knowledge of the geology of the district is obtained only with difficulty. Without the aid of electrical prospecting methods, developed for practical use by Swedish engineers about 1917, the orebodies might not have been located. Prospecting in the Skellefteaa district and the development of the electrical methods have progressed hand in hand from that time. The work has comprised a geological investigation of the mineralized regions in this part of northern Sweden, and a geophysical survey of favorable areas, covering about 150 square miles. About 25,000 m. of diamond drilling has been done, and about 40 deposits of pyrites, arsenopyrite, and chalcopyrite, with some blende and galena, have been discovered. The ores are often auriferous.

In 1921, a rich boulder of pyrite was found in a trench near Svanfors village in the Skellefteaa parish. Electrical methods were tried to locate its origin in the neighborhood, but in vain. Some boulders of leaner pyrite were found in 1923-24. The electrical survey in this district was then extended over a larger area, and a new electromagnetic method used, which had been developed by the staff of Centralgruppens Emissionsaktiebolag. Only two of the electrical indications obtained during this survey were considered favorable. A hole drilled to one of these showed only disseminated pyrrhotite in porphyry. The second hole, however, drilled to the other indication in December, 1924, disclosed an auriferous arsenopyrite orebody—the east end of the Boliden deposit.

As may be seen from the accompanying map, the Boliden orebody has a length of about 600 m. and a maximum width of 40 m. It strikes nearly east-west, dips 80 to 85 deg. to the south, and pitches 65 deg. to the east. A horizontal section through the orebody shows an area of more than 10,000 sq.m. To this must be added 1,500 sq.m. of

Fig. 2—Surface plant with ore storage in foreground

altered porphyry that contains paying amounts of gold. The ore consists of nearly massive sulphides with negligible inclusions of country rocks. Iron pyrite, arsenopyrite, pyrrhotite, and chalcopyrite, with minor amounts of blende and galena, are the chief minerals. Some complex lead and antimony minerals are also found as well as small amounts of tellurium.

Occurrence of the gold in the ore is described in detail in an article by Sture Mörtsell in the transactions of the Geological Society, Stockholm, 1932, pp. 394-414. This article has a summary in English. The main part of the gold has been shown to be in the native state, partly as microscopic or submicroscopic inclusions in the arsenopyrite. Some of it is combined with the other sulphide material, frequently replacing chalcopyrite. It also occurs in the quartz or gangue. In some sections of the mine, real nuggets or flakes of gold several millimeters long have been found. The pyrites, on the other hand, appears to be almost free from gold.

The main orebody consists of pyrites, with varying intrusions of arsenopyrite and chalcopyrite. Large, relatively pure lenses of the latter minerals are also found, generally in the vicinity of the hanging wall. These lenses contain the richest ore, with a gold content as high as 100 grams per metric ton ($60 per short ton). The orebody, which has been mapped out completely on the 50-, 90-, and 130-m. levels (see Fig. 1), and partly on the 170-, 210-, and 250-m. levels, has so far been found to have the following composition (including the gold-bearing porphyry mentioned): Sulphur, 30.2 per cent; copper, 2 per cent; arsenic, 9.8 per cent; silver, 65 grams per metric ton; and gold, 20.2 grams per metric ton; average specific gravity, 4.3. The ore may be sorted into grades of varying copper-arsenic content and gold-bearing porphyry, all of which are smelting ores; and copper-bearing pyrites, almost free from gold, with 44 to 45 per cent sulphur, which is about 10 per cent of the total ore. No valueless barren ore is produced in the sorting process. The ore remaining for smelting, after removal of the pyrites, has the following average composition: Sulphur, 28.7 per cent; copper, 2.1; arsenic, 10.8; silver, 70 grams per ton; and gold 22.4 grams per ton.

As the assay indicates, this smelting ore contains an appreciable amount of pyrite free from gold. A better separation before the roasting of the ore would offer many advantages. Comprehensive laboratory studies have been made during the last two years to develop a method for separating this barren pyrite from the remainder of the smelting ore by flotation, without appreciable loss of gold and copper. Intensive work has given such promising results that a large test plant has been built at Boliden for treatment of all the company's ores.

After the western point of the Boliden orebody had been located by diamond drilling in 1924, and a preliminary survey of the orebody had been made by about twenty more holes, a small shaft in the footwall was started in August, 1925, and arrangements were made for an annual production of 50,000 to 100,000 tons, to obtain definite data on the project. Operations started in the spring of 1926, with breaking of ore on the 50-m. level. During this work the ore was completely explored on the 50-, 90-, and 130-m. levels; exploration was also started on the 170-, 210-, and 250-m. levels, after the late increase in operations.

The ore resulting from this development work had the average analysis shown in Table I.

The figures include auriferous porphyry and pyrites. Segregated into the three grades, the ore produced up to the end of 1931 is shown in Table II.

The average composition of the ore produced is somewhat different from the calculated average of the part of the mine worked, as a large proportion of arsenic ore has been extracted from the high-grade arsenic-ore lenses. Prior to the start of the Rönnskär smelter, and as long as this smelter operated on a small scale only, the ore was exported to a German plant and to the Tacoma plant of American Smelting & Refining. The latter plant received a total of about 36,000 tons of ore, averaging 30.6 per cent arsenic, 108 grams silver, and 82 grams gold per ton.

Table I—Ore Analysis

Year	Metric Tons	Sulphur Per Cent	Copper Per Cent	Arsenic Per Cent	Silver Grams per Ton	Gold Grams per Ton
1926	15,620	27.80	3.11	19.61	103	41
1927	35.840	27.50	2.17	14.77	85	28
1928	40,075	27.70	2.29	14.22	87	32
1929	49,480	28.40	1.86	13.23	78	32
1930	63,452	29.10	1.42	13.64	75	31
1931	81,870	27.41	1.55	15.83	66	33
Total and averages	286,337	27.80	1.84	14.73	77	32

As previously stated, almost the entire Skellefteaa district is overlain with a glacial deposit. The Boliden orebody is covered completely by a sand and moraine layer, 7 to 19 m. thick. To permit mining of all outcrops, stripping of this overburden was started with two electric shovels of the caterpillar type. Of a total tonnage of 1,000,000 cu.m., about one-third has been removed to date.

About 2,000,000 tons of ore between the surface and the 50-m. level will be mined by the glory-hole method, the ore being drawn to this level and hoisted through the main shaft. Three glory holes have recently been started in the eastern section of the deposit. Altogether, 15 glory holes will be developed. A small part of the ore is mined by

Fig. 4—Loading ore from storage piles

Table II—Analysis of Segregated Ores

Quality	Metric Tons	Sulphur Per Cent	Copper Per Cent	Arsenic Per Cent	Silver Grams per Ton	Gold Grams per Ton
Au-Cu ores	259,319	30.40	1.92	16.07	85	35
Auriferous porphyry	12,152	5.79	0.59	3.06	33	12
Pyrites	14,866	44.65	1.37	0.91	35	2
Total and averages	286,337	27.80	1.84	14.73	77	32

other methods. Below the 50-m. level the slicing method is used, the slices being 5 m. thick.

The small shaft and surface plant used for development work were replaced by larger installations in 1930-31 and are now being dismantled. The new plant, designed for an annual mine production of 600,000 tons of ore, includes a vertical shaft, 2.6x9.5 m., with four hoisting compartments, two for ore and men and two for skips. The shaft, placed in the hanging wall about 80 m. from the orebody, was completed to the 130-m. level early in 1931. Ore pockets have been placed between levels near the shaft, into which the ore is dumped prior to being loaded into the skips.

Two hoists are used, each arranged for balanced hoisting, one, as stated, exclusively for ore hoisting, the other for hoisting men as well as ore cars. The skips are dumped automatically into pockets on the surface. Both hoists are of similar construction, and of the most modern type. Each has a drum divided in the center to permit hoisting in balance from any level. Depth indicators are mounted on the hoists. Both units have Ward Leonard control, and are equipped with separate converters. Each drum is driven by a motor through a double-gear train and an intermediate axle. Double brakes are used; one, an auxiliary, acts directly on the rope; the other, the main operating brake, acts on a brake drum on the intermediate axle. During hoisting, the weight on the main brake is held up by a compressed-air cylinder; the safety brake is relay-controlled, and the weight may be lifted by compressed air or by a manually operated wheel.

When the operating lever is in neutral position, an electromagnet connects the air cylinder of the main brake with the outside air, causing the weight to fall and the brake to be applied. When the lever is taken out of neutral, air is automatically introduced into the cylinder, raising the weight. Thus a separate braking lever is not required, and the hoist may be operated with one lever only.

Both units are equipped with a retarding device that automatically slows down the hoist as the cage or the skip approaches the station. This device consists of two horizontal worm gears driven from the indicators on the two drum halves. The gears are equipped with rods, which, toward the end of the hoisting period, move toward curved members attached to the operating lever, thus bringing the lever into neutral position. The members are so shaped that the retardation takes place evenly.

Special care has been taken to provide efficient safety devices. The auxiliary-brake relay makes the brake operate automatically under the following conditions: (1) overwinding; (2) power failure; (3) when the air pressure falls below a certain value; (4) when the hoisting speed exceeds a certain value; (5) when the hoisting motor is overloaded; (6) when the hoisting becomes unbalanced; (7) when the hoist operator presses a foot lever; (8) when the motor field falls below a certain value. When the auxiliary brake reacts, the generator set kicks out, and the hoist cannot again be started until the cause for this occurrence has been removed and the brake adjusted.

Table III—Hoist Data

	Hoist for Ore and Men	Hoist for Ore Only
Diameter of drum	3,000 mm.	3,500 mm.
Length of drum	3,300 mm.	3,500 mm.
Effective hoisting capacity	2,700 kg.	5,000 kg.
Weight of cage or skip	2,800 kg.	3,750 kg.
Weight of car	480 kg.	.....
Maximum hoisting distance	400 m.	400 m.
Maximum rope speed	4½ m./sec.	4½ m./sec.
Rope diameter	37 mm.	43 mm.

The unit used exclusively for ore hoisting is also equipped with pushbutton control. Change from hand operation with a lever to pushbutton control is accomplished by a single manual adjustment. Pushbuttons for starting are provided at the hoist and on every level in the shaft from which hoisting is done.

With the pushbutton control, the hoist operator is replaced by a small pilot motor, which starts when a button is pushed, taking the relay out of neutral and thus starting the hoist. To stop the hoist, the automatic retarding device is used. The hoists are built by Morgaardshammars Mekaniska Verkstads A.B. and Allmänna Svenska Elektriska A.B.

From the two shipping pockets the ore is drawn to two parallel No. 6 Morgaardshammars crushers, 90x60 cm., where it is crushed to minus 100 mm. It is then taken on two parallel, inclined belt conveyors to the sorting plant, where material smaller than 30 mm. is screened out. The ore is then washed with a spray of water and directed onto six parallel belt conveyors, 9 m. long and 0.8 m. wide, with a speed of 0.2 m. per second, of Norbergs Mek. Verkstads manufacture, on which it is sorted by hand into various grades. Under every two conveyors are four ore bins, twelve in all, with a total capacity of about 4,000 tons, or about two days' production. These discharge directly into 30-ton bottom-dump railroad cars, which are used to transport the ore to storage or directly to the smelter at Rönnskär; or the ore may be taken by belt conveyors to other bins feeding three parallel 5½-ft. Symons cone crushers, which in one operation reduce the size to about 10 mm. From the Symons crushers the ore is taken by three belt conveyors through an automatic sampling plant to storage bins at the railroad terminal, where it is loaded into railroad cars.

Adjacent to the terminal, on a level 5 m. lower, is an ore-storage yard 230 m. long, served by a 12-ton A.B. Landsverk crane with a 6-ton Titan grab bucket of 5.5 tons' net weight. The crane has a span of 40 m., with an additional 6 m. outside the track on one side. It is equipped with a 150-hp. hoisting motor, a 100-hp. bucket motor, a 25-hp.

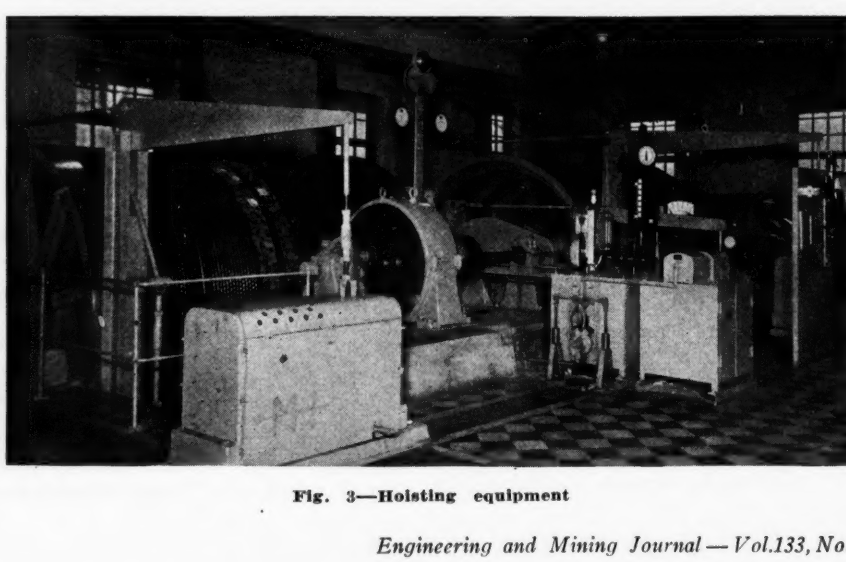


Fig. 3—Hoisting equipment

Fig. 5—Lunch room in change house

motor on the bucket carrier, and a 40-hp. traveling motor, all of Allmänna Svenska manufacture. Hoisting speed is 48 m. per minute; traveling speed of crane, 18 m., and of carriage, 80 m. per minute. Ore may be piled to a depth of 9 m., providing storage for 100,000 to 150,000 tons. The ore cars are dumped from a trestle running above the storage area, and the ore is then distributed by the crane.

In addition to the automatic sampling plant an experimental concentrator has also been built, on four levels. At the lower level are the grinding mills and a few pumps. The mills have been built for test work, and the length and feeding arrangement may be changed with conditions. On the second level, the regular pump level, space is provided for classifiers of various types, and shaking tables. The third level is reserved entirely for flotation cells, of which many types are represented, such as an 8-cell Fahrenwald unit, made by the Denver Equipment Company; a Ruth gradient flotation machine, a MacIntosh cell; several machines of the matless type; and a cell of a new type, the so-called Mörtsell flotation apparatus. The upper level is equipped with devices for reagent feeding, conditioning, thickening, and heating the pulp. For conveying the pulp, rubber hose is used, which permits changes in the flowsheet to be made easily.

Between the flotation and pump levels is an intermediate level for central sampling. The sampler, which is of local manufacture, consists of a car that runs through the entire plant and is equipped with 30 narrow cutters, each having a cutting radius of 250 mm. These take proportionate samples of all intermediate and final products in the process. They are operated with compressed air. Products that cannot be sampled in passing from the third to the other levels are pumped through this level. Samples are collected in pails of non-rustable metal, all of the same weight, which are weighed on a Toledo scale, immediately after the samples are taken and again after drying in an electric drying oven. From these weights any pulp concentration may be computed.

The ore is taken to the smelter or sent by rail to the shipping wharf at Rönnskär, a distance of 55 km. The company has built the 23-km. section of this rail line that extends from Boliden to the tracks of the Bastuträsk-Skellefteaa State Railroad, and the 2-km. section between Skellefteaa and Rönnskär. Operation of the road, which was opened in September, 1929, is by the State Railways.

In addition to the concentrator, the surface plant at the mine includes two Atlas Diesel AK-2 compressors, each delivering 30 cu.m. per minute of free air at 100-lb. pressure, and one Atlas Diesel 2PK-8 unit, of half this capacity. The compressors are installed in the hoist house. A machine shop, electric shop, drill-sharpening shop, and warehouses have also been provided. These are modern and roomy, and of sufficient size to take care of an annual production of 600,000 tons of ore. A well-equipped change house, with drying rooms, has been built, as well as offices for the staff, a chemical laboratory, locomotive round house, and garage. All buildings are heated from a central heating plant, the hot water being pumped through underground pipe lines. Power is supplied by two municipal power plants in Skellefteaa, which also generate power for the smelter at Rönnskär. Power is delivered at 33,000 volts, three-phase, and then stepped down to 1,500 volts for the larger motors, and to 220 volts for smaller motors and the lighting system.

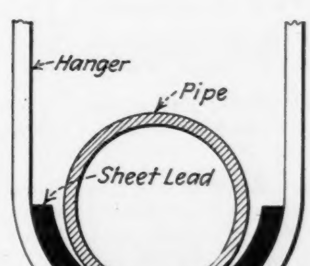
When the deposits were discovered in 1924 the surrounding country was a wilderness, lacking roads and houses. As sufficient information about the size of the deposit was gathered during the succeeding year, the company acquired all land within 2 km. of the mine. No building was permitted in the area until a complete plan with adequate regulations had been worked out. Such a plan was approved by the government in March, 1927, and building activity was immediately started by the company, as well as by private individuals. At this time the company also started to build streets and roads; a complete water-supply system, with chlorination and filtering plants; and an electric network to furnish the domestic requirements for a city with a population of 2,000. Under this plan the company has completed for workers and foremen, 38 houses, with 87 roomy and modern apartments, the majority of which have two rooms and kitchen. Moreover, it has provided 52 larger single rooms for unmarried workmen. Besides seventeen houses of varying sizes built for the staff, a hotel, mess house, and an office with two wings have been constructed.

Public buildings include fire station, post office, and public baths. A total of 111 private buildings have also been completed, including homes, boarding houses, and business structures. Assisted by the company, the municipality has built a public school for about 300 children; an evangelic society has erected a chapel; and the workmen's union a clubhouse and an athletic field. All in all, the company has taken great pains in planning and in landscaping the property, which has the appearance of a residential town rather than that of many mining camps.

■

Overcoming Pipe-Line Vibration

VIBRATION in pipe lines, set up by pumps or other machinery, may be deadened by insulating the pipe from the hanger by a piece of sheet lead, according to Lead Industries Association. A piece of 6- or 8-lb. sheet lead is cut a little longer than the bearing surface



of the pipe, and so wide that, doubled over, it still is of the same width as the hanger. This strip of lead is inserted between the pipe and the hanger, as shown in the accompanying sketch; it may be fastened to the hanger in any convenient way, although fastening is generally not required.

Among Contributors To This Issue

J. M. Callow, president of General Engineering, is an international authority on metallurgy and mill design. In the early 'nineties he was associated with Philip Argall. In 1928 he was appointed designing and construction engineer for the plant he describes in this issue, at Mount Isa, Queensland. For thirty years or so Mr. Callow has designed and built many important installations. Since 1912 he has specialized in flotation, his most notable achievement being the development of the Callow cell. He is the originator of pneumatic flotation for the treatment of ores—a method now employed by the majority of companies using the process—and is responsible for many valuable improvements in the technique of ore treatment and metal recovery.

✦

E. R. Woodward, who concludes a series of articles on the economics of lubrication in this issue, is a graduate of McGill University. He is now petroleum chemist in charge of technical work on lubrication and fuels for the Firestone Tire & Rubber Company, Akron, Ohio.

✦

Dwight L. Sawyer (Stanford) has had a varied and successful career in mining exploration work, and as geologist and mining engineer in Colorado, Arizona, British Columbia, and Cuba, on the technical staffs of Ray Consolidated, American Metal, Granby Consolidated, and other companies. He will be recalled as the author of "What of Alaska?" published last year in this journal.

C. W. Allen, author of the article describing a method of economizing in pumping expense at the Mackinaw-Gardner mine of the Cleveland-Cliffs company, Michigan. is one of the mining engineers on the staff of that company, a position he has held since graduation from Lehigh University in 1925.

From right to left: R. W. Karpinski, author of article on "Mining in French Indo-China"; the Resident and the Governor of Stung Treng Province; Enzo de Chetelat; and Igar Bresgaline

E. Wesslau has been superintendent of the Boliden mine since 1925. A graduate of the Royal Technical Institute of Stockholm (1911), he has practiced his profession as a consultant, and in association with Gruv A/B Dalarna (iron-ore mining and concentration) 1913-17; as superintendent of the Adelfors Bruk nickel-copper mine and smelter, 1916-19; and in charge of prospecting work in the Vasterbotten district of Sweden.

✦

J. J. Jakosky (Universities of Kansas and Pittsburgh) is the president and general manager of International Geophysics. Formerly associated with the United States Bureau of Mines, Mr. Jakosky is the author of many papers on the subject of geophysics, including a monograph, published by the Bureau in 1924, on underground signaling. By numerous inventions he has also contributed to the technique of electrical prospecting.

✦

Robert W. Karpinski, after graduation from the University of Michigan in 1926, held the Billy fellowship at the Institut de Geologie, Nancy, France, for two years, gaining the degree there of Ingenieur Geologue. Followed appointment as chief geologist and manager in Indo-China for Union Financière during expeditions there in 1928 and 1930. Early in 1931 Mr. Karpinski returned to Nancy and submitted his thesis—"Contributions a l'Etud Metallogenique des Vosges Méridionales"—for the degree of Doctor of Science, awarded in July.

R. H. Bedford, Grass Valley, Calif., has returned from Russia.

Huntington Adams has returned to New York from Europe.

Richard N. Hunt has returned to Los Altos, Calif., from Mexico.

T. A. Bayne, representing Sir Robert Williams in Africa, is in Uganda.

Frank W. Griffin expects to return to San Francisco from New Guinea in August.

Lucien Eaton has returned from England to the United States, and is now in Boston.

H. A. Guess, vice-chairman of Mining Trust, Ltd., which controls Mount Isa Mines, is in Queensland.

J. Neill Greenwood, professor of metallurgy at the University of Melbourne, is on a world tour.

Willis Lawrence has been appointed general manager of Cory Mines, operating in Butte County, Calif.

Heath Steele, vice-president of American Metal, and **George Harbordt,** of Cia. Minera de Peñoles, are in London.

Frank W. McLean, formerly mine superintendent with San Francisco Mines of Mexico, is at Los Angeles, Calif.

Dr. A. L. Hall has been appointed regional vice-president of the American Society of Economic Geologists for Africa.

J. R. Finlay, recently in the Globe-Miami district of Arizona, and expected to return there, has been engaged by the State of Arizona to make mine-valuation surveys.

Ernest Williams, until recently general manager of Great Boulder Perseverance, Kalgoorlie, Western Australia, is in England.

Jean Verdussen, superintendent of the leaching plant of Union Minière du Haut-Katanga, Belgian Congo, is in Brussels, on vacation.

E. C. Hutchinson, managing director of Kennedy Mining & Milling, California, is traveling through the eastern United States by automobile.

Dr. Noel H. Stearn, now examining mines in Idaho, has been elected vice-president of Southwestern Quicksilver, operating in the Arkansas cinnabar district.

James George is general manager of Palmer River Gold Dredging, operating in North Queensland. Mr. George succeeds **D. Jolly,** who resigned because of ill health.

John Lennox, formerly manager of Sardine Tin Mines, Queensland, is now general manager of Queensland Quicksilver Development, operating at Kilkivan, Queensland.

Frederick T. Kerr, formerly chief surveyor, Broken Hill Block 14, New South Wales, has been appointed government inspector of mines in Tasmania; and **J. B. Scott,** assistant secretary of mines, Tasmania.

H. W. Gepp, formerly general manager Electrolytic Zinc, of Australia, has been commissioned by the Commonwealth Government to report on the reopening of the Mount Morgan copper property, Queensland.

J. C. Perkins, steam shovel superintendent, United Verde Copper, has resigned to accept a position with the Macco-Lewis Construction Company as quarry superintendent on San Gabriel Dam No. 2 near Azusa, Calif.

Prof. Edward Sampson, secretary of the Society of Economic Geologists, announces that a field trip has been arranged to the gold belt of Ontario and Quebec, at the invitation of the governments of the two provinces, conducted under the guidance of Dr. J. A. Dresser, director of the Quebec Geological Survey. Members of the A.I.M.E., the Canadian I.M.M., and the Geological Society of America, and their friends, are invited. Dates of departure and return are as follows: From Montreal, July 31 and Aug. 6; from New York, July 30 and Aug. 7, respectively. The party will visit Kirkland Lake and Porcupine and Siscoe. Every opportunity will be provided for a careful technical study of the region traversed.

D. G. Kerr, vice-president of United States Steel, in charge of raw materials, including iron ore, coal, and limestone, will retire Aug. 1. He will be succeeded by **E. E. Ellis,** president of Universal Exploration, one of the Corporation's subsidiaries. Mr. Ellis, a graduate of Northwestern University, first entered the Corporation's employ as assistant geologist with Oliver Iron Mining, its iron-mining subsidiary.

Major H. Lockwood Stevens, secretary of the Ross Institute, Putney Heath, London, S.W. 15, invites members of the Institution of Mining & Metallurgy who are in London to attend a course of instruction, beginning July 25, on the control of malaria, of particular interest to engineers in charge of operations in malarious districts.

Arthur D. Foote left Grass Valley, Calif., recently with Mrs. Foote, to establish residence in the Eastern United States. Mr. Foote is well known because of his work in rehabilitating and operating with conspicuous success the North Star mine, at Grass Valley. Mrs. Foote has gained national recognition as an author and magazine illustrator.

J. P. Wiser, superintendent, and **E. L. Rainboth,** engineer, of Kings Mine, Asbestos Corporation, Thetford Mines, Que., Canada, were visitors recently at the mines of Miami Copper and Inspiration Consolidated, to study block-caving methods. They returned to Canada by boat from New Orleans.

H. W. Aldrich, superintendent of the leaching plant of Inspiration Consolidated, recently elected a governor of Rotary International, is attending conventions at Victoria, Vancouver Island, and Seattle.

Paul Fournarier, professor of geology at the Liege mining school, Belgium, recently visited the iron and copper mines of Michigan and Minnesota.

A. H. Douw, geologist with Rhokana Corporation, recently visited mines in the Bisbee, Globe-Miami, Superior and Ray districts of Arizona.

M. C. Haas recently returned from Russia to the United States, after completion of a contract with the U.S.S.R.

Dr. C. K. Leith has been nominated for the presidency of the Geological Society of America.

Obituaries

Frederic S. Overton, secretary and director of the Ingersoll-Rand Company, on June 4, at New York.

✦

H. T. Ferrar, assistant director, New Zealand Geological Survey; at Wellington. Doctor Ferrar was geologist to Scott's first expedition to the Antarctic.

✦

Edward H. Shackell, managing director of Electrolytic Zinc, director of Mount Coolon Gold, Amalgamated Zinc (De Bavays), Electrolytic Smelting & Refining, and other companies; at Melbourne; aged 64.

✦

R. M. Keeney, president of Pittsburgh Crucible Steel, vice-president and director of Crucible Steel of America, and a director of Snyder Mining, operating on the Mesabi Range, Minn.; at Pittsburgh, Pa., June 5; aged 48.

✦

Felix J. Thomure, traffic manager, St. Joseph Lead Company, May 24, of angina pectoris. He had been associated with the company for more than fifty years; formerly vice-president and general manager of Mississippi River & Bonne Terre Railway and Missouri-Illinois Railroad.

✦

W. A. Clark, 3, grandson of the late Senator Clark, of Montana; as the result of an airplane accident in Arizona; aged 30. A graduate of Columbia University, Mr. Clark practiced in Butte until the Clark properties were sold to the Anaconda company. He recently became associated with United Verde Copper.

✦

A. D. Ledoux, president of Pyrites Company, Ltd., subsidiary of Rio Tinto; at New York, June 5; aged 65. Mr. Ledoux, a graduate of the Columbia School of Mines, served during the war as chairman of the pyrites committee of the Council of National Defense and on the committee on ferro-alloys of the Iron & Steel Institute.

✦

J. W. Gregory, professor of geology, Glasgow University, president of the Geological Society of Great Britain, Fellow of the Royal Society, geological explorer, scientist, author; on June 2, on the Upper Amazon, by the capsizing of a canoe, during an expedition for the purpose of studying volcanic movements in the Andean region; aged 68.

✦

J. W. Richards, assayer and chemist; at Denver, Colo., June 18; aged 76. After experience in Cornwall, where he was born, Mr. Richards came to the United States in 1876, and had been identified with the mining industry in Arizona, Utah, California, and Nevada, where he established in Denver as an assayer in 1899. He was a member of the Rocky Mountain Club and several other societies.

Sir Dorabji Jamsetji Tata, on June 3 at a sanitarium in Bavaria. Sir Dorabji was chairman of Tata Iron & Steel, the foremost metallurgical enterprise in India, and regarded as the founder of the iron and steel industry in that country.

✦

Gilberto Luna, mine superintendent, Cia. Minera y Beneficiadora de Indé, Durango, Mexico; at his home in León, Guanajuato, May 7, while on vacation. A graduate of the Guanajuato School of Mines, and a valued contributor to *Engineering and Mining Journal,* Mr. Luna was widely known in southern Mexico as "El Ingeniero." He served on the staffs of Mexican, American, English and French mining companies. An associate writes in tribute: "A brilliant, highly educated, and unassuming Mexican gentleman, Gilberto Luna endeared himself to all working with him or under him by reason of his abilities, courage, reliability, and devotion to his work. Long service in a few companies limited the number of friendships he might otherwise have made; but those who knew him intimately will mourn the loss of a true *compañero,* whose back was always found touching his chief's in any emergency, in mine or mill or in politics. And operators in Mexico since 1910 will need no explanation of what the last word covers."

✦

George F. Kunz, vice-president of Tiffany & Company, an authority on gems; at New York, June 29, of cerebral hemorrhage; aged 76. Doctor Kunz, who was honored by Columbia (A.M., 1898); Marburg, Germany (PhD., 1903); Knox College (Sc.D., 1907), maintained a keen interest in geological and mineralogical research throughout a long and successful career, being the author of many articles and books. When only 23 years of age he was appointed gem expert to the Tiffany organization, subsequently acting also as special agent for the United States Geological Survey, and entrusted at various times with charge of exceptional displays of gems at important expositions, including those of Paris (1889) and Chicago (1893). An ardent collector of precious stones, he contributed much by influence and interest to the upbuilding of the collection at the American Museum of Natural History in New York City. His sympathies were varied and keen—he was active also in historical work—and he was a familiar figure at national gatherings of mining engineers in New York. He gave freely of his own knowledge and was a frequent contributor to *Engineering and Mining Journal,* an appreciation from his pen appearing in the June issue. A few days before his death he planned with the editor for the publication in this magazine of a review of an important new treatise on the genesis of the diamond, concerning which he evinced the enthusiasm of youth. His passing will evoke national and international expressions of tribute and respect; and his place as a student and a scholar of one branch of the exquisite in nature, as a scientist who made a hobby of his profession, cannot be easily filled.

The Study of Elementary Geology

A Review by Dr. Donald M. Fraser

AN INTRODUCTION TO GEOLOGY. Third Edition. *By William Berryman Scott. Vol. I, Physical Geology; pp. 604, fig. 264; price $3.50. Vol. II, Historical Geology; pp. 485, fig. 125; price $3. New York: The Macmillan Company.*

Publication of the third edition of William Berryman Scott's treatise constitutes a third entry into the field of recently revised textbooks on elementary geology.

Doctor Scott, in the first pages of Vol. I, places the reader in his proper position in our solar system and in the earth's spheres. Following preliminary remarks, wherein additional facts concerning the nature of the earth's interior, movements affecting its surface, and the age of the earth are given, the student is guided through 23 chapters dealing with more than a dozen distinct topics. These include rock-forming minerals, the three divisions of rocks, vulcanism, diastrophism, sedimentation, and the constructive and destructive action of wind, water, and ice. Chapter headings are similar to those usually found in an elementary textbook of geology, and the method of treatment is not novel. However, the incorporation of recent facts and theories and the abundance of excellent illustrations make the book readable as a text and understandable as a quick reference work.

The chapter on volcanic eruptions and the discussion of the mechanics of intrusion and extrusion are interesting and stimulating in the general consideration of volcanoes and magmas. Specifically, comparisons such as that of the results of the independent study of the mechanics of eruption of Doctors Day and Perret are of great interest. Diastrophism and earthquakes, their causes and the results of each, are handled in greater detail and in a more definite manner than in previous editions. The introduction of the newer conceptions of the origin of mountains and of ore deposition brings the chapters dealing with these subjects up to date.

In Vol. II Doctor Scott gives an excellent résumé of the preservation, importance, and inferences of fossils. He discusses the various divisions of geological time, starting with the chapter on Pre-Cambrian, in which the views of Lawson, Adams, and Coleman are reviewed, and their respective divisions of the Canadian listed.

To give a clear impression of the mass of detail in a textbook of this kind is difficult, but from the following excerpts one may get an idea of the nature of the many summarizing paragraphs which are of great aid in assimilating the details:

On page 54 Doctor Scott says: "Palaeozoic life underwent remarkable changes in the course of the era, all the great groups of animals and plants continually giving rise to new forms, which gradually replace the old. While every division and subdivision of the Palaeozoic, down to the zone of a few feet in thickness, has its own characteristic fossils, yet the life of the era, as a whole, possesses a marked individuality which is radically distinct from everything that came after it. There is, with great diversity, a certain unity of character in the successive assemblages of animals, or faunas, and of plants, or floras. The era is as remarkable for what it lacked as for what it possessed." And, on page 83: "The life system of a geological period is not to be regarded as static, as something established at the beginning of the period and remaining substantially unchanged until its end. That is the conception postulated by the old theory of Catastrophism which has been supplanted by the theory of Evolution. Aside from any theory, it is a matter of simple observation that, as the fossils are traced upward through a series of strata, they undergo continual change and modification, in consequence of which it is possible to subdivide the beds into zones, only a few feet thick, each zone characterized by an assembly of fossils which occur nowhere else. Passing from one system or series to another, from which it is divided by unconformity, the change in the fossils is abrupt: if sedimentation is uninterrupted, the change is gradual; but, whether apparently sudden or gradual, there is always change: it is the law of life."

Again, on page 307: "The history of the Cenozoic Era leads by gradual steps to the present order of things, though, climatically, there were violent breaks in continuity. Naturally, fuller and more diversified records have been preserved of the Cenozoic than of any preceding time, because the destructive powers of denudation have not yet been able to sweep them away. The very fullness is an embarrassment, when it is endeavored to arrange the multitudinous events in chronological order." Finally,

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Modern Electrometallurgical Practice

A Review by B. H. Strom

HANDBUCH DER TECHNISCHEN ELEKTROCHEMIE, Vol I, Part 2. *By Victor Engelhardt. Pp. 331, illus. Leipzig, Germany: Akademische Verlagsgesellschaft m.b.H.; Rm. 32.*

With the exception of comparatively short chapters on refining of gold and silver, and a short discourse on rare metals, the second volume of Doctor Engelhardt's comprehensive handbook of technical electrochemistry is devoted to the electrometallurgy of copper. Not since the appearance of Addicks' "Copper Refining," little over ten years ago, has the subject been so successfully treated. Although the art of electrolyzing copper long since reached a state of development where fundamental changes are not likely to occur, minor improvements have taken place during the last decade, and important additions have been made to available refining capacity.

The chapters on electrolysis with soluble anodes have been contributed by Dr. W. Schopper, of Norddeutsche Affinerie. His discourse opens with the customary treatment of the electrical and chemical phenomena of the process, composition of electrolyte, types of electrodes, electrical connections, and cell arrangements. Chapters on the treatment of anode slime and purification of the electrolyte are also included. The author goes into great detail in describing equipment and operating practice at the leading refineries in the United States and abroad, including the recently completed Canadian refineries. An interesting description is given of a typical method of cell inspection to insure a good power efficiency. Other chapters deal with the production of starting sheets, construction of cells, and analysis of metal losses in the process. Fire refining of the cathodes, being outside the scope of the book, is referred to only briefly.

Electrolysis with insoluble anodes, a process offering interesting possibilities in the future metallurgy of copper, is ably treated by Dr. Georg Eger, of Siemens & Halske. Among the difficult problems are selection of an effective leaching solution and proper depolarizing agents. Interesting descriptions are given of the five important plants operating this process, the Chuquicamata plant of Chile Copper; the Potrerillos plant of Andes Copper; the Ajo plant of Phelps Dodge; the Inspiration plant; and the Panda plant of Union Minière. These plants have an aggregate annual capacity of about a quarter of a million metric tons of electrolytic copper.

The text is accompanied with good illustrations and many interesting charts and tables. Succeeding volumes, to appear soon, will be received with great interest.

on page 359, he says: "The life of the Miocene had a much more modern aspect than had that of the older Tertiary, the Eocene, a statement which applies to all classes of animals and plants, and except for the mammals, which continued their rapid development, the chief difference between Miocene and Recent organisms is to be found in their geographical distribution, where the difference is often striking."

The final chapters, tracing life through the Tertiary and Quaternary, make an excellent ending to a textbook seasoned by the many years' experience of its well-known author.

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Three Reviews by the Editor

BUSINESS LOOKS AT THE UNFORESEEN. *By W. B. Donham. New York: McGraw-Hill Book Company; Whittlesey House; $2.50.*

In this book the author makes proposals whereby he hopes that a "better adjustment of business to the society of which it is a part" may be effected in "preventing the next depression from assuming a magnitude comparable with this one," averring that the concomitant conditions, although not accurately predictable as to exact time and intensity, "are known to have a habit of recurring with greater or less intensity."

Admitting the gravity and accepting the inevitability of these visitations under the prevailing system, a study of antecedents might have been suggested; but Dean Donham prefers "an effort to define methods by which adequate leadership where foresight is unavailable may cope with these recurring crises. For such purposes," he maintains, "the study of causes is of secondary importance. It is more important to study methods of effecting the adjustment of business to its social environment."

On the thesis that "never have the general standards of living been so high" in the United States, the author emphasizes the dependence of the existing system on the "mass-production luxury industries," explaining that "The leadership required is not the leadership of one man. It is group leadership." The layman has heard much of late about the need for leadership, and he will now wonder whither he is to be led by the luxury-industry revivalists.

The latter two-thirds of the text is devoted to "Current Problems and Plans," a section that would have been more useful for reference purposes if the volume had been indexed.

THUNDER AND DAWN — The Outlook for Western Civilization, with Special Reference to the United States. *By Glenn Frank. New York: The Macmillan Company; $3.50.*

Glenn Frank's life has been one of determination, courage, purpose, achievement. A well-informed reader of his latest book is therefore predisposed in his favor. In one important respect he will not be disappointed: "Thunder and Dawn" is a fine example of the best in English literature; but the inspiration for his analysis of conditions in the Western world before and since the War will strike an unresponsive note among the majority of those who should read a book of this character. The opening scene, as described in the prologue, is laid in the home of a "distinguished American banker," where several notables are being entertained. The host, perturbed by what he feels is the "palsy" that has fallen upon "leadership," propounds many pertinent questions on the trend of the race—biologically, psychologically, economically, politically, spiritually. Doctor Frank has essayed to answer these questions in a book that deserves careful study.

The barest of outlines of contents would take more space than is available here; but engineers will be primarily interested in his treatment of the machine as an influence in modern civilization. Like most preachers, the author appears to have been overwhelmed by the effects on our exterior life of advancing technology. He quotes the opinions of the mystic and the muckraker, finally coming to the conclusion that Western man has betrayed the machine he has evolved. The problem that confronts the author is to accept the fact that the machine is here to stay, without stressing the unhappy results that have ensued because of an illogical distribution of economic power, largely responsible for disequilibrium; and Doctor Frank handles the subject with tact and skill. The needs and aspirations of the masses are not ignored. "Even one superb leader, with a devotion to science and a passion for humanity, might tip the scales toward renaissance," he believes.

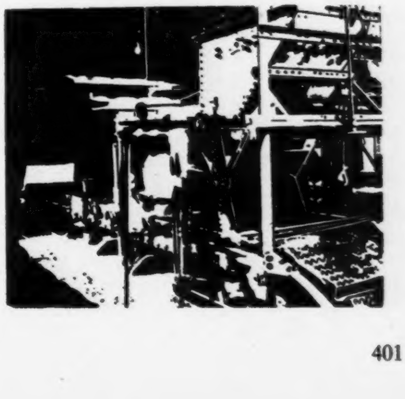
In the last chapter the author dissociates himself from the social atmosphere that pervaded the prologue. He admits the treason of a statesmanship that involves acceptance of responsibility for educational and economic control. He calls for more and better leadership, denying that his thesis is "the facile generalization of a frightened academician. . . ." In the final pages he is courageous enough to admit that "events are proving that a wider distribution of wealth is essential to the solvency and success of capitalistic industrialism. . . . What industry pays in wages is an investment in industry's market. . . ."

THE GOLD STANDARD AND ITS FUTURE. *By T. E. Gregory. New York: E. P. Dutton & Company; $1.50. London: Methuen & Company, 3s. 6d.*

Appearance of this succinct and scholarly analysis of an important tool in the operation of international trade, dependent on the maintenance and stimulation of a mining industry, is timely. The author, an economist of high repute, defines the term "gold standard" with appropriate historical references, and outlines its operation in recent years, particularly in respect to the problem of international equilibrium. The status of Great Britain, and the cause and effect of recent monetary changes there, are discussed in detail. Professor Gregory concludes his study with an analysis of the probable effect of readoption and of the various alternatives to readoption of the gold standard in British countries.

So much has been written as to the alleged failure of gold as a backing for financial and commercial operations in recent years that discussions of this kind must be salutary. Of particular interest is the destruction by Professor Gregory of the thesis advanced by Mr. Maynard Keynes recently—that Great Britain was in a favorable position to bargain with gold-standard countries before re-commitment to a definite monetary policy. Professor Gregory, who attributes departure from the standard in England to the effect of an international banking panic, ascribes the British attitude at present to inability rather than unwillingness to readopt. Observers believe that every effort is being made to facilitate an early return to a stabilized currency in respect to gold.

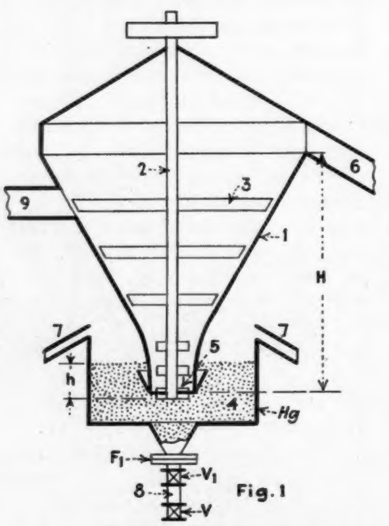
The subject of gold in its relation to commerce and finance was recently reopened by the publication of a report by the economic authorities, representing ten leading countries, who constitute a delegation appointed by the League of Nations. Majority opinion holds that the supply of gold is adequate for all purposes, and has been adequate during the crisis, thereby disposing of a misconception that, by thoughtless repetition, has beclouded the issue for several years.



INDUSTRIAL PROGRESS

Concentrator-Amalgamator Is Devised at Houghton College of Mines

A. T. Sweet, head of the department of metallurgy at Michigan College of Mining and Technology, has devised a piece of ore-dressing equipment for concentrating gold-bearing sands and pulps and amalgamating the gold. He calls it a "concentrator-amalgamator." Its features are shown diagramatically in the sketches in Figs. 1 and 2. Its application in a flowsheet is shown in Fig. 3.



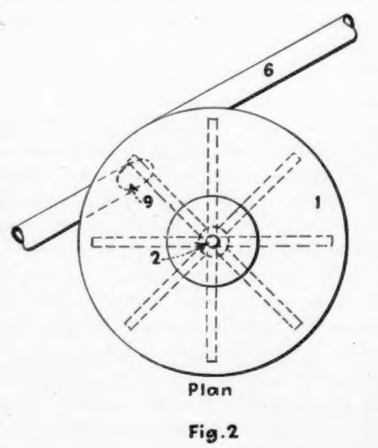


Fig. 1—Diagrammatic sketch of concentrator-amalgamator indicating essential features. Fig. 2—Top view, diagrammatically, of device as illustrated in Fig. 1.

Essential features of the new equipment are indicated in Fig. 1 as follows: a cone shell (1) having a cone angle or pitch somewhere between the angle of repose of thickened slimes and 90 deg. from the horizontal; within the cone, mounted on a shaft (2), a series of horizontally revolving vanes (3) designed to be rotated by the tangentially in-flowing pulp, thereby employing otherwise-wasted power to stir the pulp; the bottom discharge of the cone set in a box (4) filled with mercury, under the surface of which the ore material discharged is forced by a depressing vane (5) on the bottom end of the central vane shaft (2), the height of the mercury above the cone-discharge point being sufficient to maintain the desired head of pulp in the cone; a launder (6) taking the discharge from the top of the cone; a discharge launder (7) at the top of the mercury box; and an amalgam and mercury discharge (8) at the bottom of the box, arranged to permit continuous operation.

Experiments have shown that 60 deg. is the most desirable pitch or cone angle, and that the diameter of the cone may be any given amount and is not necessarily related to the height. The vanes, except the depressing vane at the bottom, may be other than vertical, or inclined as desired, for particular conditions, a 45-deg. pitch being found desirable.

Operation of the machine is as follows: The mercury well (4), Fig. 1, is filled with mercury so that the height, *h*, of the mercury, or depth of immersion of the small end of the cone, will just balance the hydraulic head due to the ore pulp filling the concentrator cone. The mixture of ore and water, or pulp, is admitted through the tangential feed opening (9), submerged below the level of the liquid in the cone. The pulp is under a suitable head, *H*, Fig. 1, and enters the cone tangentially, striking the large vane or propeller. Its kinetic energy, as it falls, is partly converted into work and turns the propeller shaft by its impact against the vane. Its quantity and speed can, of course, be governed by the size of feed or entrance opening and the head or pressure at which it enters the cone.

In treating slimes, the impact of the ore particles and water against the propeller, causing the latter to revolve, decreases the velocity of the particles and water, and the heavier particles settle in the center of the cone, while the constant swirling of the contents of the cone, caused by the tangential entrance of the pulp and the subsequent stirring action of the vanes, throws the slime and lighter particles to the periphery. In treating sands, rotation of the shaft by mechanical means is necessary. The presence of the ore in the cone increases the apparent specific gravity of the water, and the slimes and smaller sand particles are ejected through the tangential overflow opening (6) at the periphery. The larger and heavier particles of sand, which settle to the bottom of the cone, are forced under the surface of the mercury by the action of the small impellers so that subsequent amalgamation or settling of those particles that are heavier than mercury takes place, while the particles that are lighter than the mercury float to the surface of the latter and are discharged through launder (7). Water may be added to the surface of the mercury to sluice out these materials. The mercury surface may also be suitably agitated. Furthermore, the discharge from any concentrating or classifying device could similarly be forced under the surface of the mercury by mechanical means or by sufficient head of ore pulp and water.

The mercury amalgam may be tapped through valves V and V_1, and, when necessary, the heavy non-amalgamating metals may be recovered by closing V and opening V_1. After the excess mercury has been squeezed out of the amalgam or the mercury has been suitably distilled from it, the mercury may be recycled.

Several functions characterize the machine, as follows: (1) To permit and assist light minerals to overflow at the top as tailing. (2) To permit and assist heavy minerals and gold and other metals heavier than mercury to sink. (3) To force contact of all heavy minerals with mercury by passing them through the mercury and so promote amalgamation. (4) To avoid sending a large volume of materials through the mercury, so causing it to flour and go to waste. (5) To permit withdrawal of heavy amalgam and heavy metals. (6) The agitation of the pulp in contact with mercury abrades the metallic surfaces and renders amalgamation more probable.

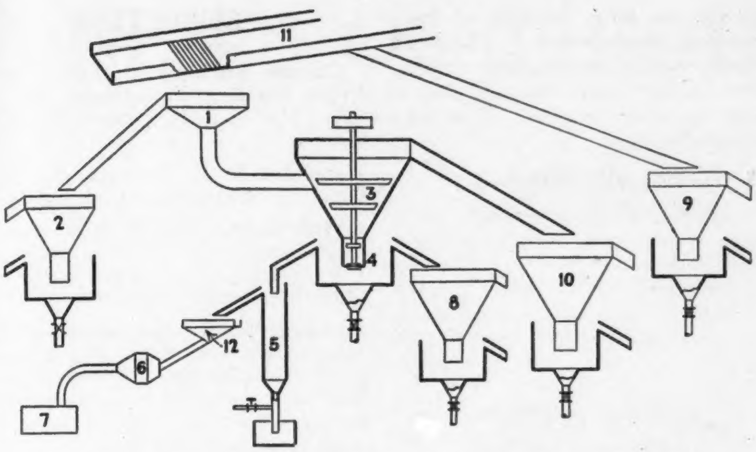
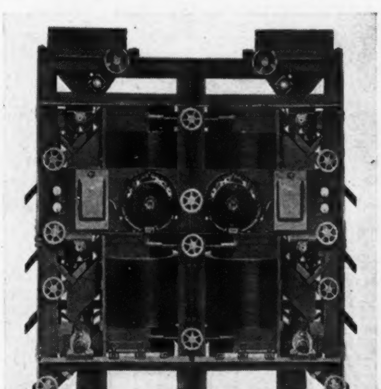


Fig. 3—Hypothetical flowsheet indicating possible application of concentrator-amalgamator

The water from the overflow of the cone may be recovered by well-known devices used for dewatering slimes or suspensions and returned to the system.

Fig. 3 shows a typical layout of a plant in which the proposed equipment might be used. A settling tank (1) receives the grizzly discharge of a sluice box (11) and overflows to a concentrator-amalgamator (2). The grizzly undersize goes to one or more concentrator-amalgamators (3) in parallel or series or both, which remove the gold or other heavy metals and minerals. Mercury carried over with material discharging from mercury container (4) through mercury from concentrate is recovered in hydraulic trap (5). Overflow from (3) is treated in concentrator-amalgamator (10). Another concentrating cone (8) is shown treating concentrate from (3). Concentrating cone (9) is treating undersize and fine material discharged below a plate bottom in a plate-lined launder or sluice. At (6) and (7) are indicated possible treatment of concentrates by regrinding and amalgamating or treating otherwise. A settling tank is shown at (12).

Negotiations relating to the manufacture and sale of the concentrator-amalgamator are said to be progressing.



New magnetic separator is a "four-high" double unit

Feebly Magnetic Materials Cleanly Separated

Great capacity and heretofore unattainable separating intensity are said to be features of the new magnetic separator (Type IR), developed by Dings Magnetic Separator Company, Milwaukee, Wis. Separations made include: mica from feldspar, iron oxide from bauxite, dolomite from gypsum, and oxides of iron and imbedded oxide particles from silica sand. Inasmuch as a large number of minerals, in addition to iron, are magnetic to a certain degree, the possibility of making accurate and delicate separations is indicated. These would include: improving the purity of a product now made; lowering the cost of producing certain materials that already require separation; and, possibly most important, making magnetic separation and purification practical for treating minerals, or mineral deposits, hitherto considered untreatable by such means. An accompanying table lists 36 magnetic minerals, and gives their attractive force in terms of iron.

The magnetic effect utilized is produced with a massive horseshoe-type electromagnet having tapered pole pieces, as shown in the accompanying diagram. Between these poles and the bridge bar, or keeper, are laminated rolls, one opposite each pole. The keeper has ends shaped to conform to the curve of the rolls. Clearance between keeper and rolls is a minimum to reduce flux resistance. Thus, the lines of force are concentrated almost completely in the two air vents between the rolls and the poles of the electromagnet. These magnetic zones present a field strength of 18,000 gauss.

In operation, the material to be treated flows by gravity on to the upper induced roll, which, being of magnetic iron, draws the magnetic portion of the material to its surface and holds it there until it passes the bottom dead center. When the lines of force are reversed, the separated material drops off into an inclined chute. Although the first roll, it is said, will remove most of the magnetic material, even where feebly magnetic, a second roll is provided, on which the non-magnetic material is again treated. All material is given four passes through the magnetic zone. Successive passes bring out additional magnetic material until the amount is infinitesimal.

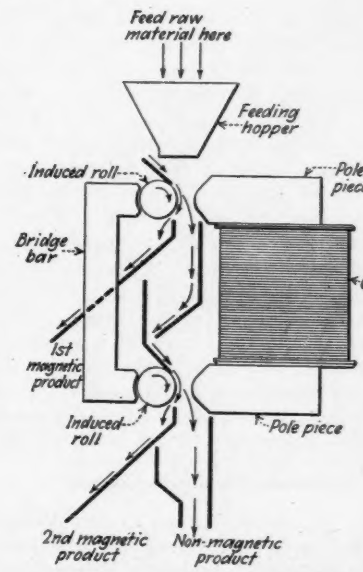


Diagram of method of producing magnetic effect in new separator

The new machine is shown in a cut presented herewith. It is a so-called 4-high double unit, having a total of 40 ft. of separating zone. For such materials as silica sand, its capacity is rated at approximately 8 tons per hour. This, the manufacturer claims, is about eight times greater than that of any

Relative Magnetic Attractive Force of Various Minerals

Based on Attractive Force of Iron = 100

Iron	100.00	Argentite	0.27
Magnetite	40.18	Orpiment	0.24
Franklinite	35.38	Pyrite	0.23
Ilmenite	24.70	Sphalerite	0.23
Pyrrhotite	6.69	Molybdenite	0.23
Siderite	1.82	Dolomite	0.22
Hematite	1.32	Bornite	0.22
Zircon	1.01	Apatite	0.21
Limonite	0.84	Willemite	0.21
Corundum	0.83	Tetrahedrite	0.21
Pyrolusite	0.71	Talc	0.15
Manganite	0.52	Arsenopyrite	0.15
Calamine	0.51	Magnesite	0.14
Garnet	0.40	Chalcopyrite	0.12
Quartz	0.37	Fluorite	0.11
Rutile	0.37	Zincite	0.10
Cerussite	0.30	Celestite	0.10
Cerargyrite	0.28	Cinnabar	0.10

other super-high intensity separator previously made.

Attention is directed by the makers to the fact that, when the horseshoe-type electromagnet is used, the lines of force do not stray, so that the force can be concentrated where used. A uniformly low current consumption has been obtained by using a great number of turns and a relatively low ampere winding. The mechanical load has been reduced to a minimum by use of anti-friction bearings on all rolls and elimination of intricate belts and gears.

Engineers who worked on the design noted that when the power was first turned on in one of the early experimental models, the force was so great that the structural frame supporting the magnet was drawn out of shape. To conquer this tendency, stronger members welded together and made of non-magnetic materials were used.

A New Dry Air-Filter

A dry air-filter of novel design and sustained high efficiency has been developed by the Coppus Engineering Corporation, Worcester, Mass. As a filter medium, it uses an all-wool-felt glove placed over a welded and rust-proof wire frame, so that it can be easily slipped off and on. This sifts the dust particles out of the air. It is held in position and sealed at the edges against leakage of dirty air by a spreader grid, which draws the individual pockets of the glove tautly over the frame. This design provides an unrestricted passage for the air to reach the surface of the filter medium, and an open passage on the clean air side, thus giving a minimum resistance.

Blasting Device Developed

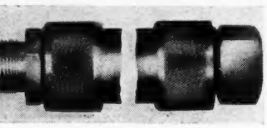
A new shunt, known as the Wassen shunt, has been developed by the Hercules Powder Company, Wilmington, Del., for enamel-wire electric blasting caps. It is made by winding the end wires around a small piece of metal and is as effective as the old type using twisted ends. It can be more easily untwisted and taken apart without distortion of the wires. Shunting of blasting cap wires is important in that it prevents accidental explosions from loose wires coming in contact with a source of current.

Some New Explosives

A series of new explosives which, although free running powders, are actually dynamite of special grades in loose form, has been developed by the Du Pont Company. They are known as Red Cross Blasting Nos. 2, 3, and 4 F.R. and are particularly designed for use in sprung holes. No. 2 is said to be especially adapted for replacing black powder in this work. Nos. 3 and 4 are well adapted for top loads in certain types of well-drill work where they have the advantage over regular cartridge dynamite in that they completely fill the holes because of their free-running characteristic. The most economical way to detonate free-running powders is by means of an electric blasting cap with a primer of at least 40 per cent strength.

Hose Coupling Improved

The male and female ends of a coupling of improved design for high-pressure hose are shown in a cut presented herewith. Such parts as wing nut, spud, and clamp bolts and nuts have been eliminated. The part carrying the male thread is so inserted in the hose that it cannot be pulled or blown out. The tapered iron pipe thread on both ends is standard. Brass is used throughout, eliminating rust and corrosion. The manufacturer is the Wil-Bro Corporation, 88 Second St., San Francisco.



Male and female ends of new hose clamp

Clamp for Power Transmission

For use in stringing distribution lines and overhead ground wires, a small dead-end clamp, developing a minimum ultimate strength of 10,000 lb., has been introduced by Ohio Brass Company, Mansfield, Ohio. It will accommodate A.C.S.R. or copper conductors, ranging from No. 6 to 4/0. High slip strength is provided by the V-shaped seat and by the curvature of the clamp body.

Another Light Drill

An improved drifting drill, weighing 142 lb. mounted and of an over-all length of 28 in., has been introduced by Gardner-Denver Company, Quincy, Ill., for mine and quarry work. The air connection may be placed at the side or the rear of the machine as desired, and the water can be admitted either on the back or the side. All parts are lubricated from an integral reservoir.

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INDUSTRIAL NOTES

A. Leschen & Sons Rope Co., St. Louis, Mo., is celebrating its seventy-fifth anniversary this year.

Stephens - Adamson Manufacturing Company of Canada, Ltd., Belleville, Ont., has concluded an arrangement with the Orton Crane & Shovel Co., of Huntington, Ind., for the manufacture and sale in Canada of Orton locomotive cranes, dipper shovels, clamshell and orange-peel buckets, traveling gantry and cantilever cranes, and similar equipment. This will be known as the "Saco-Orton" line.

BULLETINS

Chrome Brick. E. J. Lavino & Co., Bullitt Building, Philadelphia, Pa. Bulletin No. 1-13-17, improved chrome brick.

Rubber. B. F. Goodrich Co., Akron, Ohio, "A Wonder Book of Rubber."

Wire Rope. John A. Roebling's Sons Co., Trenton, N. J., "The Splicing of Wire Rope." A 36-page book of instructions, amply illustrated.

Storage Battery Locomotives. Atlas Car & Manufacturing Co., Cleveland, Ohio. Catalog 1245. Specifications and data on equipment for electric haulage underground and on the surface.

Rock Drills. Worthington Pump & Machinery Corp., Worthington Ave. at Warren St., Harrison, N. J. Bulletins Nos. W-1200-B2 and W-1200-B3, covering drills for mines, quarries and contractors.

Crane. Bucyrus-Erie Co., Department L-88, South Milwaukee, Wis., Pictorial Bulletin, "Loadmaster," handy utility crane.

Air Compressors. Worthington Pump & Machinery Corp., Worthington Ave. at Warren St., Harrison, N. J. Bulletin No. L-620-S2, vertical single-cylinder, two-stage, 10.7 to 61 cu.ft. per minute displacement.

Quarry Plants. Smith Engineering Works, Milwaukee, Wis. Bulletin 267-C. Telsmith Blue Book, containing a number of plans, with the equipment necessary in each installation, for plants of various capacities ranging from 15 to 300 tons per hour.

Motors. Reliance Electric & Engineering Co., Cleveland, Ohio. Bulletin III. Type AA induction squirrel-cage motors.

Welded Design. Lukenweld, Inc., Coatesville, Pa. Bulletin No. 2. Lukenweld Construction, Method of Manufacturing Parts for Machinery and Equipment; 22 pages.

Motors. Ideal Electric & Manufacturing Co., Mansfield, Ohio. Bulletin 210. Noel polyphase capacitor motors. Twenty pages.

Hydrogen Generator. Ajax Electric Co., Frankford Ave. and Allen St., Philadelphia, Pa. Paper describing ammonia dissociator for producing hydrogen and nitrogen gas.

Circuit Breakers. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Catalog No. 2246. "Nofuze" load centers, panelboards, switchboards, and industrial breakers, using "De-ion" circuit breakers; 76 pages.

Dust Collectors. Blaw-Knox Co., Pittsburgh, Pa. Catalog No. 1391. Framed bag dust collectors and supplementary equipment.

Clamshell Buckets. Wellman Engineering Co., Cleveland, Ohio. Six-page folder. The new Wellman Champion series of Favorite and Hercules buckets.

Standardized Buildings. International Derrick & Equipment Co., Columbus, Ohio. A catalog of 52 pages.

NEWS OF THE INDUSTRY

WASHINGTON, D. C.

Committee Reports Silver Bill. The revised bill recently reported by the Senate Banking Committee, providing for the purchase of not more than 5 million ounces silver per month until July 1, 1938, reads as follows:

A bill to authorize the purchase by the Government of silver produced in the United States, to provide for the issuance of silver certificates in payment therefor, to provide for the coinage of such silver, and for other purposes.

Be it enacted, etc., That silver bullion, the product of mines situated in the United States and of reduction works so located, may be deposited at any United States mint for sale to the United States at any time prior to July 1, 1938; and the Director of the Mint is directed to purchase silver so tendered, not in excess of 5,000,000 oz. per month, at the market price of silver in the United States as of the date of tender, if such market price of silver at such date is not in excess of 10c. an ounce above the average market price of silver for the three preceding calendar months. The Director of the Mint shall continue to obtain and keep the necessary statistics to determine the price of silver for the purposes of this act, and shall publish the same at least every 30 days, and shall deliver such statement of prices to any person, firm, or corporation tendering silver for purchase by the United States Government under this act.

SEC. 2. The silver bullion purchased under the provisions of this act shall be subject to the requirements of existing law and the regulations of the mint service governing the methods of determining the amount of pure silver contained, and the amount of the charges or deductions, if any, to be made; but such silver bullion shall not be counted as part of the silver bullion authorized or required to be purchased and coined under the provisions of existing law.

SEC. 3. Payment for silver bullion purchased under the provisions of this act shall be made in silver certificates, which shall be issued for the purpose in denominations of $10, $5, and $1, and there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, so much as may be necessary for carrying out the foregoing provisions of this act. Silver certificates so issued, and silver certificates heretofore issued, or any silver certificates reissued, shall be legal tender in payment of all debts, public and private, except where otherwise expressly stipulated in the contract, and shall be receivable for customs, taxes, and all public dues. Such certificates, when held by any national banking association or Federal reserve bank, may be counted as a part of its lawful reserve.

SEC. 4. The silver bullion purchased under the provisions of this act shall be coined into standard silver dollars and subsidiary silver coin sufficient, in the opinion of the Secretary of the Treasury, to meet any demands for redemption of silver certificates issued under the provisions of this act, and such coin shall be retained in the Treasury for the payment of such certificates on demand. The bullion so purchased and obtained under this act, except so much thereof as is coined under the provisions of this act, shall be held in the Treasury for the sole purpose of the redemption of the certificates issued hereunder and in the manner herein provided. Any such certificates or reissued certificates, when presented at the Treasury, shall be redeemed in standard silver dollars, or in subsidiary silver coin, at the option of the holder of the certificates: *Provided*, That in the redemption of such silver certificates issued under this act, not to exceed one-third of the coin required for such redemption shall be made in subsidiary coins, the balance to be made in standard silver dollars.

SEC. 5. When any silver certificates issued under the provisions of this act are redeemed or received into the Treasury from any source whatsoever, and belong to the United States, they shall not be retired, canceled, or destroyed, but shall be reissued and paid out again and kept in circulation; but nothing herein shall prohibit the cancellation and destruction of mutilated certificates and the issue of other certificates of like denomination in their stead, as provided by law.

SEC. 6. The Secretary of the Treasury is authorized to make rules and regulations for carrying out the provisions of this act.

The Senate agreed, on June 29, to participate in a world monetary conference on silver. A sum of $40,000 was voted for the expenses of delegates to such a conference.

Assessment Work Requirement Suspended. The President has signed the bill introduced by Representative Phil D. Swing of California granting suspension for the 1931-'32 fiscal year of the requirement for assessment work on unpatented mineral claims. The text of the resolution is as follows: "That the provisions of Section 2324 of the Revised Statutes of the United States which requires on each mining claim located and until a patent has been issued therefor not less than $100 worth of labor to be performed or improvements aggregating such amount to be made each year be and the same is hereby suspended as to all mining claims in the United States including Alaska during the fiscal year from July 1, 1931, to July 1, 1932." The resolution does not require the filing of any affidavit of intention to hold one's claims, as was the case in the war-time exemptions.

CALIFORNIA

Lawsuit Changes Venue. On June 20, before the U. S. Court of Appeals at San Francisco, Consolidated Coppermines presented briefs and arguments in appeal for a reversal of the Judge Norcross decision that granted Nevada Consolidated the right to continue open-pit mining at Ruth, Nev., without interference from underground mining by Coppermines. John P. Gray argued for the strict observance of Article IV of the contract between the two companies. William E. Colby, counsel for Nevada Consolidated, defended the Norcross decision, and showed that Article IV must be construed with the other provisions of the contract. He further maintained that it referred strictly to underground ores and excluded the open-pit ores provided for in another part of the contract.

Gold Activity Unabated. The Potosi property, west of Redding, has been sold to C. F. Harvey and B. F. McNaughton. The property was originally a hydraulic mine, but a quartz vein was recently explored with success and mill construction is proposed. . . . The Peterson property near Jackson is reported to have made a substantial clean-up. Negotiations are in progress to reopen the old Gwin mine. . . . At Lonely Camp, east of Rademacker, prospectors are active and shaft sinking is in progress. In Fresno and Kern counties are many small placer operations of the rocker and sluice-box types. . . . A new ore strike is reported at the North Star property of Empire-Star. Rich gold-ore specimens were reported to have been stolen from the Idaho-Maryland mine office. . . . Milling operations have been started at the Paramount property near Auburn. Mill construction is nearly complete at the Beebe property, near Georgetown, and operation will begin soon.

NEVADA

Rich Ore in Goldfield Consolidated. Bonanza ore has been discovered on the 90-ft. level of Jumbo claim No. 2 of the Goldfield Consolidated, at Goldfield. Fitzgerald and Svorcan, about four months ago, took over a leased block, 200x200x200 ft., abandoned by A. Biltoft, who had taken it after abandonment by the Foster brothers. The new leasers exhausted their resources and credit in a search for ore. In a final examination in the drift about 90 ft. from the shaft they panned a sample of the floor. Colors showed. They decided to put in a round of holes. Pannings from the bottom showed several colors to the pan. At 6 ft. the ore assayed $25 per ton; 23 ft. below the floor of the drift they found high grade. At last report the bottom of the winze showed 4 ft. of ore, half of which runs from $350 to $700 per ton, and the remainder averages $60 per ton. The find has stimulated wide interest and activity.

Activity at Old Edgemont Property. H. H. Carpenter, president and manager of Atlas Gold, operating 85 miles north of Elko, has placed order for a redwood pressure pipe to connect with hydro-electric plant. Machinery is also on the way for a 50-ton pilot mill, employing flotation. Construction of a 200-ton plant will follow. . . . Lucky Tiger Combination is developing the Buckskin National, 75 miles north of Winnemucca. The shaft has been carried from the 200- to the 400-ft. level, and about 1,000 ft. of drifting done on the 300 and 400 levels. The mine was recently examined by R. T. Mishler, who is supervising the work.

Progress at Silver Peak and Summit Springs. The old camp of Silver Peak is taking on new life. Stamps have been introduced ahead of the ball mills and rod mills, and capacity is nearly doubled. . . . Calumet Gold Mining, of Silver Peak, recently shipped two carloads of ore yielding over $5,000. Two more carloads en route will run around $100 per ton. . . . The latest gold rush is to Summit Springs, 19 miles east of Mina, where wire gold has been found. The same character of ore is present in the Belleville mine, in Telephone Canyon. Another discovery, same character of ore and high values, was made between the Storm Cloud and the Belleville. The country is filled with prospectors.

UTAH

California Buys Utah Sulphur. Utah Sulphur Industries, Beaver County, has resumed production of sulphur, most of which is shipped to California for fertilizer and other agricultural uses. New equipment is being installed and new buildings are to be erected at Sulphurdale. . . . Production of the Yankee mines of A. S. & R., which amounted to 1,500 tons in May, was nearly doubled in June. . . . Ore has been shipped recently from the Rio Tinto mine, Mountain City, Elko County, running as high as 47 per cent copper, with silver and gold. The deposit, consisting mostly of chalcopyrite and chalcocite and some bornite, has been opened for a length of 250 ft. The ore is trucked 50 miles to Elko and shipped to the A. S. & R. smelter at Garfield, Utah. R. C. Dugdale is superintendent. . . . Directors of Tintic Standard and Eureka Standard declared dividends on June 6 of 5c. and 3c. a share, respectively. This is the second dividend paid by Tintic Standard this year, and, amounting to $57,665.75, it will bring the total to $14,401,888. Eureka Standard's dividend of $44,987, also the second this year, will bring the company's total to $359,901.60.

MICHIGAN COPPER COUNTRY

Tailings Provide Copper-Ore Reserve. Calumet & Hecla's tailing deposit in the Hecla and Tamarack sand banks will remain untreated pending demand for larger production. The Calumet deposit is nearly exhausted, and the remaining tailing is not as rich as the sands already treated. Nevertheless, the remaining supply will be a source of cheap copper for seven to ten years. An average of nearly 11 lb. per ton has been recovered, at a cost of less than 7c. per lb. Companies in the Michigan copper district have large deposits of amygdaloid tailing. These sands are amenable to flotation. Deposits along water fronts have been scattered, but a large volume remains, particularly in the more compact piles near land. Sampling gives assurance that the millions of tons of tailing in the district form a potential source of copper, which can be recovered at a profit when the market warrants reclamation. The sands can be treated at a cost of about 22c. per ton, including regrinding and flotation. Average recovery will be about 6 lb. per ton. Deposits far removed from operating mills can be treated in portable plants.

Copper Range Makes Profit. Copper Range is keeping production down to about 1,000,000 lb. copper per month, but is developing much ore in the Champion mine and keeping well ahead in reserves. Yield is kept high by selection, and by flotation treatment, averaging about 44 lb. per ton of rock treated. Costs have been cut to a minimum by wage and salary reductions. Men with dependents work three or more days a week, and others two days or less, spreading employment among the greatest number. A substantial part of Copper Range production is taken by C. G. Hussey & Company, of Pittsburgh, controlled by Copper Range. This company is making a small profit in spite of business conditions.

PACIFIC NORTHWEST

Finding Work for Unemployed. S. K. Atkinson, president of Idaho Gold Dredging, is urging that, out of Idaho's quota of funds that may be appropriated by Congress for direct relief, a part be set aside to grubstake groups of men, under proper supervision, in some of the choicer sections of the placer gold fields. Mr. Atkinson believes that placer areas in the Northwest could be opened up at comparatively small expense, and hundreds of men could earn wages or near wages; but these men must be grubstaked to the extent of about $100 each. This grubstake would provide the necessary camp and mining equipment, and sufficient supplies to last for the first 30 or 40 days, after which time each group could be placed on a self-sustaining basis. Within 90 or 100 days the grubstake money could be returned to a revolving fund, where it would become available for further grubstaking purposes. To accomplish return of the money to the grubstake fund, Mr. Atkinson proposes that a percentage be deducted from each clean-up, and also that the other expenses of each camp be deducted and the balance divided among the men in each group. The groups would comprise units of from 25 to 50 men each, and each group would have an experienced placer miner in charge to direct the work, maintain order, and keep the accounts. He would be directly responsible to the administrator of the grubstake fund. Mr. Atkinson believes that the original fund could be safeguarded and returned to the government at the close of this emergency period.

Flotation Mill Operates Successfully. The Gold Hill mine, Quartzburg, in the Boise Basin, has been equipped with a 50-ton plant, comprising Hardinge mill, Dorr classifier, and Fahrenwald flotation cells, designed by A. H. Fahrenwald after laboratory studies. The mill is now running smoothly, and making daily 1½ tons shipping concentrate containing between $200 and $300 gold per ton. The ore, mixed oxide and sulphide from the 200-ft. level of the Mayflower mine, carries lean iron pyrites with a smaller proportion of arsenopyrite, bismuth, lead, zinc and antimony, with which the gold is associated. These constitute the products sought for by differential flotation, the rejected pyrite being of too low a grade to stand transportation cost to the Salt Lake custom smelter.

The Mayflower is owned by a close corporation of six Boise business men and one prominent New York chemist. Gold Hill is the oldest gold mine in Idaho. Credit for this promising new enterprise is due to the company's manager, J. B. Eldridge, of Boise. It greatly strengthens the potentialities of the west end of the Gold Hill vein system, and of several other blind vein courses along the Quartzburg porphyry belt to the east in which they occur, and whose erosion has manifestly been responsible for more than half of the placer gold output of the Boise Basin.

Gold Strike Starts Alaskan Rush. Discovery of free gold in the Nuka District, 78 miles west of Seward, has sent prospectors into the region by every available mode of travel. A 15-ft. ore vein, averaging $45 a ton, is reported from the Cord mine, Willow Creek district.

ARIZONA

Copper Tariff Enthusiasm. Cheering throngs paraded the streets and highways of the Globe-Miami district when word of the signing of the bill carrying a tariff on copper was received, on June 6. Services held in church the following Sunday paid tribute to the men who had sponsored and promoted the fight for the tariff and dwelt on the benefits expected to accrue to the industry as a result. Governor George W. P. Hunt has addressed letters to the Governors of all copper-producing states in which he urges that every effort be made to stimulate the use of copper by state institutions and individuals. Arizona 1933 automobile license plates will again be made of copper.

Tax Refund Ordered. A writ of mandamus was granted United Verde Extension on June 6 by the Superior Court of Yavapai County against the county and state, ordering the defendants to pay the mining company a tax refund forthwith. The judgments referred to are those won by the company May 19, 1930, in the amount of $192,626.78; March 10, 1932, $22,065.38;

New quarters, Department of Mining and Metallurgy, University of Wisconsin, Madison and March 10, 1932, $87,907.90. These refunds include those due and payable by state and county and by the Jerome school district. Costs in the action must be paid by the defendants. Interest also is due from date of tax under protest.

Bagdad Copper to Manufacture. George C. Thomas, general superintendent Bagdad Copper Corporation, recently announced that his company is constructing a wire-rod mill to handle ten tons of copper per hour at Sandusky, Ohio, eventually to be moved to Bagdad. . . . International Smelter at Miami was closed down June 17. Only a few of the key men are retained to maintain necessary services and for fire protection. Inspiration Consolidated has laid out 350 garden plots for use of selected employees, on the Kiser ranch, on the highway between Globe and Miami. The plowing and ditching were done by the company, with the assistance of employees and the county. The company has run pipe lines and will supply water to all plots. Miami Copper has 165 similar plots near by. Much interest is being taken in these projects, which bid fair to help many an employee with the will to work to bridge the present unemployment situation.

IRON COUNTRY

Iron Mining Profit Small. Ore tonnage mined and ore shipments made may dwindle in the Lake Superior Iron Country, as consumption falls, but taxation is maintained. This is illustrated, in the assessment of Michigan mines, by statistics for 1931 compiled by F. G. Pardee, mine appraiser, and W. Osgood, geologist, and issued by the Geological Survey Division of the Department of Conservation at Lansing. Although the tonnage from underground and open-pit mines in 1931 was only 7,539,646, compared with 13,699,017 in 1928, 15,227,231 in 1929 and 13,541,168 in 1930; and although shipments in the same year were only 5,557,520 tons, compared with 14,332,872 in 1928, 16,889,448 in 1929, and 11,157,480 in 1930, the state and local taxes paid by active mines in 1931 were greater in amount than those paid in either 1928, 1929, or 1930, being $3,841,883 in that year, compared with $3,404,425 in 1928, $3,436,058 in 1929, and $3,514,532 in 1930. Thus state and local taxes per ton mined amounted to $0.5079 in 1931, compared with $0.2485 in 1928, $0.2260 in 1929 and $0.2595 in 1930. . . . The effort to keep men employed is shown in other figures. Although the number of days worked in 1931 averaged 170, compared with 282, 288, and 287, respectively, in 1928, 1929 and 1930, the number of men employed in 1931 was 6,112, compared with 9,206, 8,996 and 8,554 in the respective years used for comparison. Average daily wage was $4.963 in 1931, against $4.704 in 1928, $4.915 in 1929, and $4.997 in 1930. Average yearly earning was $843.71 in 1931, compared with $1,324.18 in 1928, $1,415.52 in 1929, and $1,436.55 in 1930. Tons per man per day changed little, being 5.30 in 1931, 5.26 in 1928, 5.87 in 1929, and 5.49 in 1930. . . . Average costs per ton, for the five-year period 1928-31 inclusive, for Michigan underground mines only, were as follows: Mining, including labor and supplies, $1.5571; deferred mining cost. $0.1075; taxes, $0.2946; general overhead, including general office and general superintendence, fire insurance, "contingent," and depreciation, $0.2349; transportation (rail freight, $0.7818, Lake boat freight to Lower Lake ports, $0.7452, and cargo insurance, $0.0019) total, $1.5289; marketing, $0.0580. Total ore cost was therefore $3.7810 per ton, giving a gross ore profit of $0.7441 per ton on the basis of a Lake Erie value of $4.5251 per ton. Charges not included in the figures given in the foregoing are: Royalties, $0.2952 per ton, and interest on borrowed money, $0.0430 per ton. The term "gross ore profit" does not represent true profit, as much ore is sold at a discount. The tax burden on iron mining in Michigan is much lighter than in Minnesota.

BRITISH COLUMBIA

Byproduct Industry Active. From the Trail plant of Consolidated Mining & Smelting considerable shipments of chemical fertilizers to Hawaii and the Dutch East Indies are being made. During the past month a consignment of 6,000 tons went to the former and 3,000 to the latter. Directors of the company announce that if at the Ottawa conference the existing preference on Canadian lead and zinc be permanently established, and the British market assured thereby, it will be possible to plan for the future in a way not now practicable. Earnings for the half year are estimated to be somewhat in excess of operating expenses, exclusive of allowance for depreciation and depletion. Unsold stocks of metal are below those at the commencement of the year. The company during the past three years has been prospecting placer ground on Manson and Slave creeks, in the Omineca district. It recently installed machinery, including dragline-scraper equipment, preliminary to mining operations. The mill is expected to be in operation by the early fall. . . . A revival of interest in gold mining in the Nelson district is reported and several formerly productive mines have been acquired and reopened. . . . Diamond drilling on the Golden Cache and Bonanza claims, in the Lillooet district, which yielded remarkably rich specimen gold ore many years ago, is to be undertaken by a Vancouver syndicate, which recently acquired these properties. . . . Alexandria Gold has granted an option to the Mid-Continent Goldfields, whereby the latter is to receive a 50 per cent interest in the Alexandria Mining Company, in return for an expenditure of about $200,000 on mine development and the erection of a mill. The option previously held by the McVittie-Graham Mines on this property, situated on Phillips Arm, was not exercised, the results of development having proved disappointing.

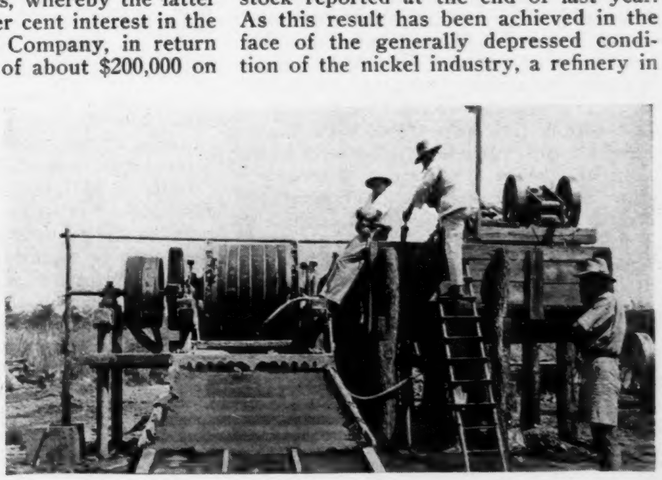
CANADA

Great Bear Lake Developments. The 1932 season's surface work at Great Bear Lake is disclosing some long sections of the high-grade native silver found last fall, widths of 12 to 18 in. being shown. Shipments of this ore and of the high-grade pitchblende have been prepared. Underground mining is to proceed next winter on at least one property, the Eldorado; and an oil-driven plant is on the way in. A pilot plant to produce the radium-barium concentrate from the ore is operating in Ottawa, using a new process developed by the Canadian Department of Mines. Representatives of the Belgian radium company using Katanga ores conferred with the Canadian authorities in Ottawa in June.

Pilot Mills for Testing Mines. The Canadian vogue for pilot mills to test the merits of gold deposits in the initial stages of development may make mines out of several properties that, like Siscoe, in Quebec, were condemned repeatedly on the basis of channel sampling and core drilling. Ventures, Ltd., has announced that a small mill will be erected next winter on its Island Lake property in the far northeast of Manitoba, close to the Ontario boundary. The outcrop is on a small island, on which a shaft has been started by hand. Diamond drilling has indicated a series of lenses of ore of high grade, but with erratic mineralization, over 1,000 ft. in length so far as drilling has proceeded. Access during the summer months is by airplane only. . . . Gold production at Siscoe continues at about $75,000 a month from $15 ore. The mine is showing up well in the new levels now being opened from 600 ft. down.

Another Canadian Refinery Planned. Falconbridge Nickel mine and smelter, at Sudbury, operated at full capacity during the first half of 1932, the output being about 3,000,000 lb. nickel from 60,000 tons of ore, with copper and precious metals as byproducts. Current sales of nickel have exceeded production, thus reducing the rather heavy stock reported at the end of last year. As this result has been achieved in the face of the generally depressed condition of the nickel industry, a refinery in

Herman ball mill under erection at an African gold mine



Canada, to supplement the company plant in Norway, may be expected as soon as general conditions improve. The mine can sustain a much larger output than the present 350 tons a day, and the smelter is ready for simple additions that will double its capacity.

Ontario Makes New Gold Record. Ontario Bureau of Mines reports for May a record gold output, valued at $4,079,320, average recovery being $8.70 per ton. Kirkland Lake produced $2,104,757 from 149,188 tons, an average of $14.13. Porcupine mines treated 285,759 tons and recovered $1,810,000, an average of $6.30 a ton. Mines in northwestern Ontario, chief among which are the Howey and the Moss, produced $164,554 from 34,700 tons, an average of $4.75 a ton. Teck-Hughes, Kirkland Lake, produced gold to the value of $586,124. Adding the exchange on New York funds, the value in Canadian currency was $639,000, the best month in the history of the mine, probably to be exceeded during June as a result of higher mill heads. Lake Shore is maintaining a production rate of over $1,000,000 per month. Progress is being made with the tailing re-treatment plant to be built under joint arrangement by Lake Shore and Wright-Hargreaves, and construction is expected to start soon. The plant will have a capacity of 1,500 tons of tailing a day and will utilize the flotation process. Hollinger Mines, of Porcupine, will increase daily mill tonnage from 4,700 to 5,000 tons. Recent developments underground are encouraging and the step-up in tonnage reflects the general improvement in the mine. . . . During the first six months of 1932, Canadian gold mines will pay out a total of $7,881,000 in dividends. This compares with $6,469,400 and $5,584,800, respectively, for the corresponding periods in 1931 and 1930. Of the total of $7,880,-900, all but $595,100 is being paid by Ontario gold mines.

American Tariffs and Imperial Preference. As a result of the duty imposed on copper entering the United States, this metal will occupy a more important position in the discussions of the forthcoming Imperial Economic Conference at Ottawa, in July, than was originally anticipated. If a duty had not been imposed by the United States, no request would probably have come from Canadian producers for an Imperial preference. The situation is now changed; but so far as Empire metal is concerned, difficulties remain. Imperial preference applies only to goods finished within the Empire. Rhodesian copper producers would therefore be in a position different from that of the chief Canadian producers, because a substantial part of the Rhodesian output is now refined in the United States, and would thus automatically be outside British preference. This will no doubt accelerate construction of plants in Great Britain for the refining of Rhodesian copper.

BOLIVIA

New Exchange Rate Offsets Restrictions. Tin mining in Bolivia is unsettled because of uncertainty as to the application of the new banking laws and the reduction applied to production. From June 1, Bolivia will be allowed a total production of 15,000 tons of metallic tin per year, against about 18,000 tons at present, if the recommendations of the Tin Producers' Association are adopted. A two months' shutdown of all the mines is proposed, but the companies prefer a curtailment of production with continuous operation. Bolivia has passed a law requiring all mining companies to deposit with the Banco Central de Bolivia 65 per cent of the drafts received from the sale of tin ore. The percentage is felt to be too high. However, the new exchange law, regulating the value of the boliviano according to the price of tin, has been of help; more bolivianos are now received for the tin sold, and fluctuations in the exchange (except as tin price changes) are avoided. The government seems to be trying to work out the problems to the best interests of all concerned. . . . Araca, recently taken over by Patiño Mines, will be almost shut down until conditions improve. Meanwhile, the concentrator is to be remodeled and the camp placed in good condition. . . . Improved exchange allowed the Corocoro copper properties to resume operation.

MEXICO

State Cooperates With Foreign Companies. Applications for sanctions to suspend activities have been filed with the Ministry of Industry, Commerce and Labor by American Smelting and Refining for its Santa Eulalia mine, near Chihuahua City, which employs some 500 men; and by Potosi Mining for its mine near the same city, which employs 1,200 men. . . . Bacis Gold and Silver Mining, operating at Bacis, near Estacion Otinapa, Durango, has installed a cable tramway to convey ore from mine to mill. . . . Gold and silver bullion is now being regularly dispatched by airplane from the property of San Luis Mining, near Estacion San Dimas, Sinaloa, to the port of Mazatlan, whence it is transported by steamer to California. . . . The Federal Conciliation and Arbitration Board has upheld a ruling by the Monterrey (Nuevo Leon) labor board that the strike of a group of workers in some shops of American Smelting and Refining in that city is illegal, a decision that upholds the company. The Board has permitted the company to break collective labor contracts it made with the strikers and to hire new workers to supplant the disgruntled ones. . . . Although the worth of minerals and metals produced in Mexico in April was 12,150,055 pesos (about $4,000,000 U. S. Cy.) and was 17.95 per cent greater than the outputs in March, it was 36.72 per cent lower than those of the corresponding month of 1931, finds the Department of National Statistics. The Department attributes the decreased value of April productions, compared with those of the same month last year, to the depreciation of the worth of Mexican currency in terms of the American dollar. . . . Difficulties with labor unions caused by the proposal of a French enterprise operating copper mines at Santa Rosalia, Lower California, to dismiss at least half of its 2,000 employees, were settled by compromise, whereby the workers' organizations agreed to accept a 40 per cent personnel reduction. This agreement was reached at a conference of company representatives and workers' delegates in Mexico City under the auspices of the Ministry of Industry, Commerce and Labor.

EUROPE

Copper Refineries in England. Tests made in a pilot plant by British Insulated Cables over several months, involving treatment of several hundred tons, preceded the present erection of a refinery of 1,000 tons' weekly capacity, to handle Roan Antelope copper. The plant at Prescot, Lancashire, will be operated by British Copper Refiners, a subsidiary of British Insulated Cables, which is financing the enterprise. Roan Antelope has been granted a participating option. Blister copper from Roan Antelope is nearly the equal of Lake metal. Pilot-plant operations resulted in the production of metal with a conductivity of 101-102. Copper wire for all electrical purposes will be made from the refined product of the new plant, which also intends to produce cakes, billets, bars, and other commercial forms for the general trade. The new company is understood to have contracted to take the output of Roan Antelop's smelter over a long period, at the price of electrolytic at the time of delivery, less a small deduction for refining charges. In consequence, Roan Antelope production is already sold far ahead at the average of coming prices. . . . Rio Tinto-Rhokana Corporation may also start erection of an electrolytic copper refining plant somewhere in England, probably on the Manchester Ship Canal, to cost about £1,000,000, but confirmation must await official announcement. Rhokana Corporation's mill and smelter are running steadily and satisfactorily; though a portion of the product has been sent to electrolytic refineries, the bulk of it is being sold in the form of blister on the Continent and in England.

Developments on the Continent. Flotation experiments in Germany on Mansfeld ore have proceeded to a point indicating that a pilot plant will be erected in the near future, according to Metallwirtschaft. Hand sorting is being practiced at present, the nature of the ore inhibiting mechanical methods of concentration. . . . Trepca Mines (Jugoslavia) reports a notable increase of tonnage treated and production, resulting from the addition to the concentrator that went into commission in the last half of May. This change was effected far ahead of schedule, the plan being to complete the addition not later than August. Good grade of ore of excellent milling character, nearness to market, and efficient management are enabling the company to operate profitably on the prevailing low prices of lead and zinc.

Austrian Gold Mines to Reopen. Reopening of the gold mines in the Tauern mountains of Austria, worked in the Middle Ages, is planned, according to a report from Commercial Attaché Gardner Richardson, Vienna, to the U. S. Commerce Department. Reserves are estimated at about 26,000,000 tons, containing from 18.9 to 60 grams a ton. An important section lies near Nassfeld, in which the Austrian Government owns a one-third interest. Reopening of these properties is expected to result in a profit of about $2,000,000 annually.

AFRICA

Low-Grade Ore Report Issued. The report of the commission appointed to consider reduced working costs, to add a large tonnage of low-grade gold ore to the reserves of the Witwatersrand, published recently, states that "Reduction of 2s. per ton milled in working and yield costs will probably result in an increase of at least 50 per cent in the future average life of the Witwatersrand. Reduction of 4s. per ton milled in working costs and yield will probably result in an increase of more than 100 per cent." One conclusion urged that assistance be rendered to make possible the exploitation of rock at present unpayable. Revision of the power contract was advocated.

Of annual working cost of about £31,000,000, £2,300,000 is spent on electric light and power and compressed air, more than £2,000,000 on explosives, and nearly £1,000,000 on coal. Two members of the Commission recommended a 10 per cent reduction in mine salaries and wages, followed by a similar reduction throughout the Union, which, they maintained, would reduce mine working costs by at least 1/4d. per ton milled.

Rand Exploitation at Depth. Discussion of the currency policy of the Union before the Parliamentary Select Committee brought a statement by Chamber of Mines officials that abandonment of the gold standard would result in an additional revenue of eight million pounds per annum to the mines. In response to a question, Mr. P. M. Anderson, vice-president of the Chamber, considered that two million pounds would probably go to the shareholders, the remainder being absorbed in mining lower-grade ore and making it available. Mr. Anderson explained the difference between the low-grade ore that exists alongside high-grade ore, and may profitably be treated with it; and the type of ore that is better termed deep-level ore. Operations, he said, are now passing beyond the range of the existing vertical shafts. Unless a row of deeper vertical shafts is sunk from the East Rand Proprietary to Roodepoort, this ore will remain unavailable. Mr. Anderson said that capital was not obtainable for such enterprise under existing currency conditions. In five years, he estimated, from £8,000,000 to £12,000,000 would be expended for the construction of seven shafts if South Africa were to cast in its lot with sterling and abandon the gold standard.

Gold Output Breaks All Records. Output of gold in the Transvaal during May reached 965,644 oz., comparing with 910,279 oz. in the same month of 1931. Output for the five months, 4,726,-271 oz., compares with 4,458,127 in the corresponding period of 1931.

Mineral Discoveries in Uganda. Important mineral discoveries are announced from Uganda. Important finds of alluvial gold have been made in the Madi district, bordering on the Belgian Congo; Tanganyika Concessions has been granted extensive prospecting rights. Reconnaissances have recently been carried out by airplane in this territory. The principal finds to date have been made in the vicinity of M'Tibikwe and Amua. Nickel and cobalt have been found in the Kingezi forest in the Ruwenzori region, where Tanganyika owns the Kilembe copper mine.

Production Restriction Effective. The plant and several properties of Mufulira Copper, though idle because of the copper curtailment arrangement, are being kept in readiness for immediate resumption of operations. A portion of the company's stockpile ore has been sold to Rhokana Corporation, and deliveries are now being made. Ore reserves in the Mufulira, Chambishi, and Baluba properties remain at 162,000,000 tons, averaging 4.14 per cent copper, with 96 per cent in sulphides. Mufulira's quota of copper is being produced by Roan Antelope and Rhokana.

AUSTRALASIA AND MALAYA

Activity in Western Australia. Great Boulder Proprietary continues to improve in mine valuation and cash resources. A large tonnage of payable ore has been exposed. . . . A new problem at Wiluna is the control of arsenic dermatitis among employees, many of whom evade precautionary methods. The trouble had been overcome in Bendigo, Victoria. . . . On the Lancefield property at Laverton, 300 miles north of Kalgoorlie, the diamond drill has penetrated the lode at the vertical depth of 924 ft. The 18 ft. of core was hard, highly mineralized, and promising as to assay results. The company may raise capital for a new plant. . . . Lake View & Star flotation plant is 90 per cent complete to handle 30,000 tons per month. The plant is being extended to treat 40,000 tons per month, and with the exception of a Symons cone crusher, two vibrating screens, two classifiers, and a tube mill, is ready to operate to that capacity. . . . Production of gold in Western Australia from January to April, inclusive, this year, compared with the same period last year, shows an increase of 45,237 oz.

Australian Radium Developments. To treat radium ore from Mount Painter, South Australia, Australian Radium Corporation will erect at the mine a concentrating plant to handle 400 tons weekly, producing a 20 per cent uranium oxide concentrate, to be despatched to Melbourne for treatment in a new plant to be erected there. It will produce 2 grams radium per month, as well as byproducts.

Progress in New South Wales. Broken Hill South's new hauling and crushing equipment has been placed in commission and is functioning satisfactorily. As a result, costs have been reduced considerably. Metallurgical work on the South mine has now reached a high plane. In April, from ore assaying 14.1 per cent lead, 11.8 per cent zinc, and 6.0 oz. silver per ton, the flotation plant produced lead concentrate assaying 74.7 per cent lead, 3.8 per cent zinc, and 29.5 oz. silver per ton. The zinc concentrate carried 52.5 per cent zinc, 1.8 per cent lead, and 1.9 oz. silver per ton. . . . Broken Hill Block 14, to maintain the property at Broken Hill and develop and equip the Cock's Pioneer alluvial gold area at Eldorado (Victoria), will form a new company with a capital of £100,000. The Broken Hill property contains 100,000 tons of ore that can be profitably mined with reasonable lead and zinc prices. Cock's Pioneer mine is expected to yield a profit.

Queensland Produces Mercury. At Kilkivan, Queensland, Quicksilver Development has started a four-retort distillation plant, and results have been satisfactory. On a trial run, 9½ tons of ore produced 75 flasks. The plant is expected to meet Australia's domestic quicksilver requirements. . . . Excellent progress has been made in the erection of the 200-ton cyanide plant on the property of Mount Coolon Gold Mines, North Queensland. Crushing will begin early in September. After reduction in jaw and Symons crushers, the ore will be finely ground in two ball mills, classified and thickened in Dorr equipment, and cyanided. . . . At Mount Isa, good progress is being made in the erection of three new sintering machines, an additional blast furnace, and a Cottrell treater unit. To increase production, underground operations will be carried out on three shifts instead of two. Plans are being prepared for the working of the Black Star sulphide orebody. By the end of July, lead production should be 5,000 tons monthly, compared with 3,500 tons at present.

Bulolo Gold Dredging Results. For the four weeks ended April 25, the first of the two dredges to be erected in New Guinea by the Bulolo company recovered gold valued at 57,000 gold dollars from 243,700 cu.yd. This is equivalent to 12.6d. per yard on a gold basis, or only half the estimated content of the property. None of the company's bores is near the dredge; to check the boring against recovery is not possible. Equipment for the erection of No. 2 dredge is on the site, and the bottom steel plates of the pontoon have been laid.

Siamese Company Earns Profit. Renong Consolidated treated 3,097,000 cu.yd. in 1931, for a recovery of 550 tons of tin oxide, equivalent to only 6.5 oz. per cubic yard. Working costs were 1.88d. per yard, compared with 3.28d. in 1930. The 1931 dredging cost is believed to be lower than that of any other company operating in the East. . . . Siam has decided to suspend operation of the gold standard. This decision is of importance to many tin-dredging companies operating in that country, notably Ronpibon, Tongah Harbour, Katu, Renong Consolidated, Pungah, and Satupulo. These companies have sold their ore to smelters in the Federated Malay States, receiving payment in depreciated currency, but when remitting funds to Siam to pay working expenses, have had to pay an exchange premium of 25 per cent. Under the new conditions the currencies of Siam and F.M.S. will be equal.

Daily and Average Monthly Prices of Metals

June, 1932

United States Market

June	Electrolytic Copper: Domestic Refinery	Electrolytic Copper: Export Refinery	Straits Tin New York	Lead: New York	Lead: St. Louis	Zinc St. Louis
1	5.025@5.150	.....	20.750	3.000	2.900	2.80@2.875
2	5.025@5.150	.....	20.375	3.000	2.900	2.800
3	5.025@5.150	.....	20.625	3.000	2.900	2.800
4	5.150	.....	20.750	3.000	2.900	2.800
6	5.150	.....	20@20.250	3.000	2.900	2.800
7	5.150	.....	19.750@20	3.000	2.900	2.800
8	5.150	.....	19.625	3.000	2.900	2.800
9	5.150@5.275	.....	18.750	3.000	2.900	2.800
10	5.150	.....	19.400	3.000	2.900	2.800
11	5.150	.....	19.750	3.000	2.900	2.800
13	5.150	.....	19.700	3.000	2.900	2.800
14	5.150	.....	19.000	3.000	2.900	2.800
15	5.150	.....	19.300	3.000	2.900	2.800
16	5.150	.....	19.125@19.25	3.000	2.900	2.800
17	5.150	.....	19.450	3.000	2.900	2.800
18	5.150	.....	19.500	3.000	2.900	2.800
20	5.150	.....	19.400	3.000	2.900	2.800
21	5.150	5.150	19.500@19.625	3.000	2.900	2.775@2.800
22	5.150	5.150	19.700	3.000	2.900	2.750@2.800
23	5.150	5.150	19.500	3.000	2.900	2.750
24	5.150	5.150	19.350	3.000	2.900	2.725
25	5.150	5.150	19.300	3.000	2.900	2.725
27	5.150	5.150	19.200	3.000	2.900	2.700
28	5.150	5.150	19.000	3.000	2.900	2.700
29	5.150	5.150	19.600	2.950@3.000	2.800@2.900	2.700
30	5.150	4.900	20.350	2.750@2.950	2.800@2.900	2.700
Av. for Month	5.145	.....	19.659	2.993	2.896	2.777
June			**Averages for Week**			
1	5.088	.....	20.605	3.000	2.900	2.860
8	5.129	.....	20.229	3.000	2.900	2.800
15	5.160	.....	19.317	3.000	2.900	2.800
22	5.150	.....	19.467	3.000	2.900	2.794
29	5.150	5.150	19.325	2.996	2.892	2.717
June			**Calendar Week Averages**			
4	5.100	.....	20.580	3.000	2.900	2.815
11	5.160	.....	19.588	3.000	2.900	2.800
18	5.150	.....	19.356	3.000	2.900	2.800
25	5.150	5.150	19.469	3.000	2.900	2.760

Silver, Gold, and Sterling Exchange New York and London

June	Sterling Exchange "Checks"	Sterling Exchange "90-Day Demand"	Silver: New York	Silver: London	Gold London
1	368.250	371.000	28.125	16.9375	112s 9d
2	368.500	371.000	27.750	16.8125	112s 6d
3	369.125	373.125	27.875	16.8125	112s 6d
4	369.375	373.375	28.125	16.8750	....
6	368.875	373.000	28.000	16.8750	112s 4d
7	367.500	371.000	27.875	16.9375	112s 7d
8	367.000	370.000	27.875	17.0000	113s
9	367.250	371.125	27.750	16.9375	112s 8d
10	367.000	369.750	27.625	16.8750	112s 9d
11	367.500	370.500	27.750	16.9375	....
13	367.500	370.250	27.750	16.8750	112s 8d
14	366.375	368.625	27.750	16.8750	112s 8d
15	365.875	368.375	27.625	16.8125	112s11d
16	365.000	367.500	27.625	16.8125	112s10d
17	362.250	363.750	27.500	16.9375	113s 1d
18	361.500	362.750	27.500	17.0000	....
20	360.375	361.750	27.375	16.9375	114s
21	360.500	361.750	27.375	17.0000	114s 5d
22	362.125	363.375	27.375	16.9375	114s
23	361.250	362.500	27.125	16.8750	114s 2d
24	360.500	361.750	26.750	16.6250	114s 6d
25	361.000	362.000	26.750	16.6250	....
27	361.000	362.375	26.750	16.6875	114s 4d
28	360.625	361.875	26.750	16.6250	114s 7d
29	360.125	361.500	26.750	16.6875	114s 8d
30	359.875	361.125	26.625	16.6250	114s 8d
Av. for Month	364.471	....	27.466	16.844	....
June		**Averages for Week**			
1	3.69175	....	27.875	....	....
8	3.68396	....	27.917	....	....
15	3.66917	....	27.708	....	....
22	3.61958	....	27.458	....	....
29	3.60750	....	26.813	....	....

Calendar week averages: New York Silver, June 4th, 27.975; 11th, 27.813; 18th, 27.625; 25th, 27.125.

London Market

June	Copper: Standard Spot	Copper: Standard 3 Mo.	Copper: Electrolytic (Bid)	Tin: Spot	Tin: 3 Mo.	Lead: Spot	Lead: 3 Mo.	Zinc: Spot	Zinc: 3 Mo.
1	26.7500	26.7500	30.50	122.125	124.375	10.2500	10.5000	12.0625	12.3750
2	26.0000	26.0000	30.50	119.250	121.500	10.0625	10.3125	11.8125	12.1250
3	26.3750	26.3125	30.50	119.750	122.000	10.0000	10.2500	11.8125	12.1250
6	26.8125	26.8125	30.50	*No Market*		9.7500	10.1250	11.8750	12.0625
7	26.2500	26.2500	30.50	115.250	117.750	9.8125	10.1250	11.8750	12.1250
8	26.8125	26.7500	30.50	115.750	118.000	9.6875	10.0000	11.7500	12.0000
9	26.4375	26.2500	30.50	109.250	111.750	9.4375	9.7500	11.3750	11.7500
10	26.3125	26.1875	30.50	112.000	114.500	9.5625	9.8750	11.5000	11.8750
13	27.1875	27.0000	31.00	115.000	117.500	9.5000	9.9375	11.5625	11.9375
14	27.1250	27.0000	31.00	113.250	115.500	9.2500	9.6875	11.4375	11.8125
15	27.1875	26.9375	31.00	111.250	113.750	9.1875	9.6875	11.3750	11.6875
16	27.3125	27.0000	31.00	112.000	114.500	9.2500	9.7500	11.5625	11.9375
17	27.8125	27.5000	31.50	114.000	116.375	9.7500	10.1250	11.8125	12.1250
20	28.1250	27.7500	31.50	114.500	117.000	9.6875	10.0625	11.6250	12.0000
21	27.5625	27.3125	31.50	113.750	116.000	9.6250	9.9375	11.5625	11.8125
22	27.5625	27.3125	31.50	116.250	118.500	9.6875	9.9375	11.5000	11.7500
23	27.0625	26.8125	31.00	114.750	117.000	9.5625	9.8125	11.4375	11.6875
24	27.2500	27.0000	31.00	114.000	116.250	9.6875	9.8125	11.1875	11.5625
27	27.0000	26.7500	31.00	110.250	112.500	9.4375	9.5625	11.1875	11.5625
28	26.7500	26.5000	31.00	110.750	113.000	9.3750	9.5000	11.2500	11.6250
29	26.0625	25.8125	30.50	114.750	116.500	9.3750	9.4375	11.1875	11.5000
30	25.4375	25.1875	30.00	117.250	118.750	9.4375	9.5625	11.3125	11.6250
Average for month	26.872	....	30.841	114.530	....	9.608	9.898	11.548	11.866

The United States quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices of domestic class are in cents per pound.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. Contract prices for High-Grade zinc delivered in the East and Middle West are 1c. above St. Louis

Silver and Sterling Exchange

	New York 1931	New York 1932	London Spot 1931	London Spot 1932	Sterling Exchange 1931	Sterling Exchange 1932
January	29.423	29.780	13.810	19.623	485.260	342.515
February	26.773	30.136	12.432	19.573	485.551	345.141
March	29.192	29.810	13.524	18.336	485.596	363.463
April	28.279	28.298	13.120	16.923	485.764	374.731
May	27.650	27.755	12.858	16.868	486.188	367.370
June	27.250	27.466	12.707	16.844	486.291	364.471
July	28.255	......	13.197	......	485.349	....
August	27.524	......	12.815	......	485.284	....
September	28.180	......	14.101	......	451.245	....
October	29.538	......	17.153	......	388.029	....
November	32.223	......	19.393	......	371.130	....
December	30.120	......	20.023	......	336.798	....
Year	28.700	......	14.594	......	452.707	....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

Zinc

	St. Louis 1931	St. Louis 1932	London 1931 Spot	London 1931 3 Mos.	London 1932 Spot	London 1932 3 Mos
January	4.035	3.011	12.747	13.113	14.416	14.834
February	4.012	2.817	12.303	12.694	13.872	14.289
March	4.002	2.787	12.190	12.676	12.616	13.024
April	3.717	2.725	11.353	11.838	11.670	11.958
May	3.306	2.532	10.484	10.875	12.432	12.682
June	3.416	2.777	11.270	11.750	11.548	11.866
July	3.893	.....	12.280	12.802	......	......
August	3 917	.....	11.444	12.028	......	......
September	3.744	.....	11.571	12.063	......	......
October	3.377	.....	12.733	13.216	......	......
November	3 209	.....	13.845	14.247	......	......
December	3.149	.....	14.361	14.818	......	......
Year	3.640	.....	12.215	12.677	......	......

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Copper

	F.O.B. Refinery Electrolytic 1931	F.O.B. Refinery Electrolytic 1932	London Spot Standard 1931	London Spot Standard 1932	London Spot Electrolytic 1931	London Spot Electrolytic 1932
January	9.838	7.060	44.938	39.459	47.524	46.200
February	9.724	5.965	45.372	36.917	47.950	41.381
March	9.854	5.763	44.818	33.039	47.699	36.786
April	9.392	5.565	42.694	29.943	45.375	34.190
May	8.665	5.237	38.897	28.548	42.175	32.833
June	8.025	5.145	35.827	26.872	38.966	30.841
July	7.698	.....	34.402	......	37.293	......
August	7.292	.....	32.572	......	35.388	......
September	6.988	.....	31.503	......	36.148	......
October	6.775	.....	34.957	......	41.000	......
November	6.558	.....	35.854	......	41.190	......
December	6.580	.....	38.273	......	44.409	......
Year	8.116	.....	38.342	......	42.093	......

New York quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium 1931	Cadmium 1932	Aluminum 1931	Aluminum 1932
January	67.115	55.000	23.300	23.300
February	55.000	55.000	23.300	23.300
March	55.000	55.000	23.300	23.300
April	55.000	55.000	23.300	23.300
May	55.000	55.000	23.300	23.300
June	55.000	55.000	23.300	23.300
July	55.000	......	23.300	......
August	55.000	......	23.300	......
September	55.000	......	23.300	......
October	55.000	......	23.300	......
November	55.000	......	23.300	......
December	55.000	......	23.300	......
Year	56.010	......	23.300	......

Aluminum in cents per pound, 99 per cent grade.
Cadmium, cents per pound.

Lead

	New York 1931	New York 1932	St. Louis 1931	St. Louis 1932	London 1931 Spot	London 1931 3 Mos.	London 1932 Spot	London 1932 3 Mos.
January	4.802	3.750	4.604	3.550	13.872	13.905	15.084	15.128
February	4.552	3.712	4.340	3.499	13.444	13.550	14.560	14.571
March	4.527	3.150	4.276	2.993	13.128	13.355	12.345	12.634
April	4.412	3.000	4.164	2.900	12.375	12.606	11.223	11.503
May	3.818	3.000	3.651	2.900	11.491	11.778	10.673	11.036
June	3.917	2.993	3.761	2.896	11.582	11.952	9.608	9.898
July	4.400	.....	4.225	.....	12.731	12.899	......	......
August	4.400	.....	4.225	.....	11.944	11.994	......	......
September	4.400	.....	4.217	.....	11.932	12.026	......	......
October	3.964	.....	3.773	.....	13.227	13.270	......	......
November	3.937	.....	3.758	.....	14.577	14.491	......	......
December	3.792	.....	3.592	.....	15.188	15.361	......	......
Year	4.243	.....	4.049	.....	12.958	13.099	......	......

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York 1931	Antimony (a) New York 1932	Quicksilver (b) New York 1931	Quicksilver (b) New York 1932	Platinum (c) New York 1931	Platinum (c) New York 1932
January	7.317	5.976	103.000	64.900	36.000	40.000
February	7.069	6.489	100.205	66.304	34.000	40.000
March	7.127	6.188	100.423	72.537	29.538	40.000
April	6.888	5.746	102.077	72.125	26.346	40.000
May	6.524	5.170	101.140	66.380	24.980	39.500
June	6.342	5.034	92.058	59.481	37.115	37.500
July	6.802	.....	85.808	......	40.000	......
August	6.596	.....	80.115	......	40.000	......
September	6.542	.....	76.300	......	40.000	......
October	6.517	.....	72.385	......	40.000	......
November	6.679	.....	68.587	......	40.000	......
December	6.231	.....	66.115	......	40.000	......
Year	6.720	.....	87.351	......	35.665	......

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

Tin

	New York Straits 1931	New York Straits 1932	London Spot 1931	London Spot 1932
January	26.137	21.804	115.798	140.219
February	26.315	22.018	117.919	139.143
March	27.065	21.863	121.852	129.810
April	25.222	19.244	112.775	108.935
May	23.221	20.948	104.331	122.286
June	23.478	19.659	104.966	114.530
July	24.978	......	111.478	....
August	25.738	......	114.875	....
September	24.618	......	117.813	....
October	22.723	......	126.932	....
November	22.779	......	132.857	....
December	21.328	......	138.909	....
Year	24.467	......	118.375	....

New York quotations, cents per pound. London, pounds sterling per long ton.

Pig Iron[1]

	Bessemer 1931	Bessemer 1932	Basic 1931	Basic 1932	No. 2 Foundry 1931	No. 2 Foundry 1932
January	17.50	16.00	17.00	15.00	17.00	15.50
February	17.29	15.68	16.79	14.68	16.79	15.18
March	17.00	15.50	16.50	14.50	16.50	15.00
April	17.00	15.50	16.50	14.50	16.50	15.00
May	17.00	15.50	16.38	14.50	16.44	15.00
June	17.00	14.85	15.50	14.35	16.00	14.75
July	17.00	.....	15.50	.....	16.00	.....
August	17.00	.....	15.50	.....	16.00	.....
September	17.00	.....	15.50	.....	16.00	.....
October	16.92	.....	15.42	.....	16.00	.....
November	16.50	.....	15.00	.....	16.00	.....
December	16.25	.....	15.00	.....	15.75	.....
Year	16.96	.....	15.88	.....	16.25	.....

Iron in dollars per long ton. [1]F.o.b. Mahoning and Shenango Valley furnaces; freight to Pittsburgh, $1.76.

prices for the Prime Western grade.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

New York silver quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, 925 fine. Sterling prices represent forenoon market demand. Cables command a premium.

Current Statistics of Production and Stocks of Copper, Lead, and Zinc

Data from American Bureau of Metal Statistics, American Zinc Institute, and Metallgesellschaft.

All Figures Except Tin Represent Tons of 2,000 Lb.

	1931 June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1932 Jan.	Feb.	March	April	May
COPPER — North and South America												
Production, refined, daily average	3,276	3,110	2,909	2,890	2,918	2,693	2,780	......	......	......	......	......
Domestic shipments	50,217	43,144	45,816	40,459	51,348	37,436	36,972	......	......	......	......	......
Foreign shipments	33,251	26,321	29,016	22,124	21,030	20,257	26,032	......	......	......	......	......
Stocks, blister and refined	600,827	620,075	631,880	658,321	......	......	722,014	......	......	......	......	......
LEAD — United States												
Production, refined, from domestic ore	30,708	32,157	34,144	31,966	36,546	31,671	33,576	32,180	28,081	30,345	23,236	25,902
Production, secondary and foreign	3,683	4,409	5,453	3,934	4,722	3,820	4,031	3,554	3,920	3,989	3,134	2,941
Production, total, daily rate	1,146	1,179	1,151	1,163	1,331	1,180	1,213	1,185	1,103	1,107	879	930
Shipments reported	37,054	42,219	38,590	34,059	34,276	31,216	30,297	27,867	26,319	31,162	26,081	24,258
Stocks, end of month	139,698	133,958	134,977	132,804	139,796	144,057	151,380	160,257	165,933	169,091	169,091	173,929
ZINC — United States												
Production, daily average	783	689	692	712	699	684	709	723	742	726	688	601
Domestic shipments	27,604	28,460	23,599	20,902	21,163	20,327	21,005	22,472	21,896	22,576	18,046	18,087
Export shipments	......	20	......	......	......	......	......	31	......	......	......	......
Stocks, end of month	138,928	131,833	129,701	130,155	130,666	130,865	129,825	129,886	129,506	129,451	132,025	132,580
World Production Rate (Daily Average)												
Copper	4,224	3,919	3,924	4 023	3,940	4,070	3,940	......	......	......	......	......
Lead	3,995	3,691	3,906	3,654	3,806	3,980	3,976	3,938	3,872	3,598	3,596	3,720
Zinc	3,127	2,860	2,766	2,814	2,736	2,725	2,601	2,600	2,615	2,623	2,528	2,392
Tin (Metric Tons)	439	401	416	349	352	325	351	311	274	340	321	......

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